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UNITS AND STANDARDS.

On another page of this issue we give an abstract of the discussion on units and standards which took place at a recent meeting of the Institution of Electrical Engineers, of Great Britain. The discussion was opened with a report by Mr. W. Duddell, of the work of the International Electrical Congress, St. Louis. Part was taken by a number of prominent men, but no definite conclusions were reached. The consensus of opinion seemed to be that the present units and standards should be maintained until more concerted action can be assured between the different countries.

It was admitted during the discussion that the legal value of the Clark cell is too high, and that the true value is much nearer the figure given by Dr. Henry S. Carhart. The advantages of the Weston cell over the Clark cell were admitted, and it seems probable that the new cell will become the accepted standard when time has proved its constancy.

During the discussion much stress was laid upon the fact that while, from the physicist's viewpoint, there is considerable discrepancy between different standards, for commercial purposes this is negligible. This discrepancy will be removed as the standards are improved and as agreement is reached between the different countries. From the physicist's viewpoint it does not diminish the accuracy of his work, and, as more reliable figures are obtained, a correction factor may be applied.

THE INTERNATIONAL RAILWAY CONGRESS.

The importance of the International Railway Congress, held recently in Washington, is hard to estimate. An enormous amount of work was done, and a great deal of a permanent character accomplished. For the first time, electricity was one of the important factors considered. Naturally, the greatest attention was given to railroad matters which are not of special interest to the electrical engineer, but it is significant that electric traction received the serious consideration given to it.

There were three applications of electricity discussed before the congress. The one of most importance was, of course, the electrical operation of railways. Progress in electric traction was reported by Mr. W. D. Young for this country, who described what was being done by the large manufacturing companies, particularly in developing a single-phase motor. Mr. Young referred also to what had been done in Europe in the same line. M. P. Dubois, reporting for France, described what is being done there, and other reporters told how electric traction is progressing in their countries. Remembering that, but a few years ago, the suggestion that the electric motor would be used on large railway systems was laughed at, the change in sentiment during the last five years is remarkable. It should be said for the railway engineer that he is not opposed to new methods, but he does insist upon some reason being given for any change. He is conservative, and very properly so, but when a new method is developed which he is convinced it will be to the benefit of his road to adopt, he is ready to change. He insists further that it be shown beyond doubt that the new apparatus is capable of performing satisfactorily the work assigned to it. He must also be assured either that certain local conditions make the change necessary, or that the financial results will be good. Since the last meeting of the congress we have seen the electric railway grow from the city or suburban line into interurban and high-speed lines; and we are shortly to see the electric system applied on certain sections

of the largest and most important railways in this country, the conditions in these cases, however, being such that no other system could be considered.

The other uses of electricity attracting the attention of the congress were the lighting of cars and automatic block signaling. While the electric lighting of trains is being tried on a large scale, as yet it is impossible to come to any final decision as to the best of the five different systems under investigation. The experience of the reporters with the various systems differed somewhat, a system giving satisfaction in one case proving unsatisfactory in another. The general conclusion seemed to be that systems of electric lighting are giving satisfaction on the different roads, and attention was called to their advantage in certain cases for intermittent lighting in passing through tunnels, and for operating ventilating fans.

The third important use of electricity in railway work is in automatic block signaling. This application is not new. In this country automatic systems have reached such a state of perfection that it is held by many to be a safe and economical method of protecting trains on railways. In Europe the same progress has not been made. A number of instances were related, in which an automatic system was installed and operated satisfactorily for a number of years. In some cases, however, it was found that the expected economy due to the reduction in the number of employés was not attained. The general opinion seemed to be that automatic signaling, properly designed and installed, should be recognized as a suitable means of protecting train and switch movements. Its general adoption in place of existing systems is not yet to be recommended.

The reference to automatic block signals brings to mind another phase of railway work where the automatic apparatus is coming into use. This is in the automatic coupling of cars, particularly for electric trains, by which the coupling of the drawbar, the train hose and the train line is effected at the same time. This not only increases the celerity of train movements, but decreases the danger to the train hands.

An important feature of the Washington meeting was the exhibit of American railway appliances. To the foreign members of the congress this was an exceptional opportunity to examine the apparatus and devices which have contributed so largely to our success in railway building and operation.

The arrangements for conducting the congress were excellent, and a better place could not have been selected than Washington, where there are so many points of interest to every one. It would seem to be a desirable meeting-place for the foreign members of the congress, for all of them must be interested in American railway methods. Another phase of the congress work deserves mention—that is, the excellence and promptness with which the work was reported by the official organ, the *Railway Age*. This journal had a large staff at Washington, and issued daily a twenty to twenty-eight-page paper giving the official report of the work and the not less interesting unofficial discussion of matters of interest. The congress was fortunate in having this part of the work handled so ably.

THE ALUMINUM ELECTROLYTIC CONDENSER.

On another page of this issue is given an abstract of a paper presented at the recent meeting of the American Electrochemical Society by Mr. C. I. Zimmerman, on "The Aluminum Electrolytic Condenser." This is the second paper by Mr. Zimmerman on the same subject. An abstract of the first was published in the ELECTRICAL REVIEW for April 30, 1904.

In the second paper, Mr. Zimmerman describes an extension of his investigation, and points out some new and interesting properties of this peculiar device. It may be well to describe briefly the actions which are believed to give rise to the capacity effect of the aluminum electrolytic condenser. When a plate of aluminum is placed in certain solutions it behaves in a peculiar way; it allows an electric current to pass from the electrolyte to it, but it prevents a flow of current in the opposite direction. In other words, the plate acts as an electric check valve. The effect is supposed to be due to the formation of aluminum hydrate, which acts as a semi-permeable insulator—that is to say, it allows hydrogen ions to pass through it, but prevents the passage of hydroxyl ions. It is this effect which has been made use of in the aluminum rectifier. By using two plates—one of aluminum, and the other of some different material, such as carbon—a device is obtained which conducts in one direction only. Applying an alternating electromotive force to this arrangement, but one-half of each current wave will pass through the cell; the other half will be checked. However, by a suitable arrangement of similar cells, or by a combination of electrodes in one cell, the current may be rectified so that both current impulses are sent on in the same direction. The electrolytic condenser depends for its action upon the same effect. Placing two aluminum plates in the same cell gives us an arrangement which, after the first rush of current, stops all flow of current through the cell. We then have two conducting plates separated from a conducting electrolyte by two thin insulating surfaces. We have what is, in effect, two static condensers connected in series, each condenser being formed of the combination—aluminum plate, aluminum hydrate dielectric, electrolytic plate. The combination behaves in many ways as two static condensers connected in series, but it has some peculiar properties of its own.

It may be questioned whether the above statement is exact. As each aluminum plate has the property of resisting the flow of current in one direction only, it would seem that we would have, in effect, but one condenser; but a current can only pass from the electrolyte to an aluminum plate when it can pass into the electrolyte at the other end of the cell. Since each aluminum plate, in turn, prevents the passage of current into the electrolyte, there can, of course, be no passage of current from the electrolyte out. This statement should be modified by saying that, when a condenser is first connected to a source of alternating electromotive force, electricity flows out of the electrolyte until the potential of the latter is that of the lowest negative value of the source. When this point has been reached, the electrolyte can not be drained any further, and

since the aluminum plates will not allow electricity to flow into the electrolyte, it must remain at this constant negative potential. It may be considered, then, to have a constant negative charge, and as the potential of the two plates is varied by the variations of the source, this negative charge, caught in the electrolyte, will oscillate back and forth through the electrolyte from side to side, balancing at each plate in turn an equal positive charge. Although this charge oscillates through the electrolyte, there is no current passing through the dielectric coating on the aluminum plates. This coating, then, always acts as an insulator, and gives us the effect of two condensers in series.

Of course, the value of the negative charge held in the electrolyte will be changed if the condenser be connected to a source of electromotive force which has a lower negative value than the first; but, after the first rush, the electrolyte will be brought to a new negative potential, and will then change no further. If the condenser be disconnected from the source of supply, it will be found to hold a negative charge which can be drawn off by introducing an electrode of some material other than aluminum into it. It is in this point that the electrolytic condenser differs from two static condensers connected in series. The analogy could be made almost exact if one of the condensers were short-circuited momentarily, and the connection broken when the intermediate plates were negatively charged. This arrangement will hold a constant negative charge which will oscillate from condenser to condenser as the voltage at the two outer terminals of the arrangement oscillates.

So far we have been considering an arrangement in which the aluminum electrodes are of the same size. If one be made considerably larger than the other, we have two condensers connected in series, one of them having a larger capacity than the other. The negative charge taken by the electrolyte will correspond to the capacity of the larger plate, but as the capacity of the smaller plate is less, it can not hold this entire charge, and part of it will therefore remain bound to the larger plate. Introducing, now, an indifferent electrode into the cell, a peculiar effect occurs; we have, in addition to the rectifying action of the device, a condenser action. The negative charge held around the large electrode can not be taken care of by the small one, as the voltage of the latter electrode rises, and this charge will rush out of the cell through the third electrode. The voltage due to the condenser charge is added to that of the supply, causing the difference of voltage between the indifferent electrode and the small one to be greater than that of the supply. The greater the difference in size between the two aluminum plates, the more marked is this effect. The limiting value is twice that of the supply, but it can not be reached in practice, since it is possible theoretically only when the area of the small electrode is zero. This transformer action, as it were, can be carried still further, for by combining several cells in a certain arrangement, three times the maximum voltage of the supply can be obtained, and, no doubt, the effect could be carried further.

By placing three aluminum plates in the solution, and connecting them to the three phases of a three-phase circuit, a three-phase condenser is obtained, which behaves just as does the single-phase condenser. In this case, however, the bound negative charge held by the electrolyte rotates in the cell.

The aluminum condenser, as compared with static condensers, has a large capacity, due, undoubtedly, to the extreme thinness of the dielectric. Unfortunately, this property, which gives it a large capacity, limits the voltage for which it is suitable. It does not operate satisfactorily much above 100 volts, and as condensers in practice are usually required for higher voltages, this is a serious objection. If, for example, one wishes to make an aluminum condenser for 500 volts, it will be necessary to connect five such condensers in series; and since this arrangement gives a capacity of the set only one-fifth that of one condenser, five such sets would be required in parallel—that is to say, to obtain a capacity for 500 volts, equivalent to that of a single condenser, twenty-five such condensers are required. However, for low potentials the device would seem to be admirable.

The step-up transformer effect described above is also of little value practically, because it is obtained only when one electrode has a very small area; and therefore the current flowing will be small. In other words, we are able to raise the voltage, but can draw but little current from the device.

The efficiency of the condenser may be high. Mr. Zimmerman has constructed one in which the losses are only five per cent of the volt-amperes represented by the charge.

As a practical device, the aluminum condenser, as at present constructed, can have but little use. If an electrolyte could be found which would make it operative up to a thousand volts, say, it would be most valuable because of its cheapness, its indestructibility (it is practically self-healing), and its large capacity. It has been claimed that, by employing certain organic compounds as electrolytes, an aluminum rectifier has been operated up to 500 volts. How satisfactory it was, we can not say. Up to 100 volts many electrolytes are satisfactory.

THE INSTITUTE ELECTION.

At the meeting of the American Institute of Electrical Engineers held in New York city, Tuesday, May 16, the annual election of officers was announced. The Institute is to be congratulated upon its new president. Dr. S. S. Wheeler has been identified with electrical matters for nearly twenty-five years. He has distinguished himself in many phases of the work, and has added not a little to its development. He has been connected with the Institute from almost the beginning, and has served it in many capacities, being a past vice-president and at the present time a member of the board of managers. He has been interested in some of the most important undertakings of the Institute, and was largely influential in securing the new engineering building. He has been a liberal donor to the Institute library. We believe that the Institute may look forward to his administration with the expectation of a successful and active year.

The Annual Meeting of the American Institute of Electrical Engineers.

The annual meeting of the American Institute of Electrical Engineers was held in the chapter room of Carnegie Hall, New York city, May 16. The following announcements were made for officers for the ensuing year:

President — Dr. Schuyler Skaats Wheeler.

Vice-presidents — Charles A. Terry, Townsend Wolcott, Gano S. Dunn.

Managers—C. C. Chesney, Calvert Townley, Bancroft Gherardi, Charles L. Edgar.

Treasurer—George A. Hamilton.

Secretary—Ralph W. Pope.

The reports of officers and committees were presented and accepted. The secretary reported that the membership on May 1 was 3,460.

The report of the representatives of the joint committee on the engineering building was read by the secretary. This explains briefly the plans which have been adopted for the erection of the building and for bringing together the libraries of the three national societies so as to form one comprehensive engineering library. It was stated by the president that the contract for the building would be let shortly, and it is expected that ground will be broken some time next week. A statement from Dr. S. S. Wheeler was read, which gives briefly the arrangements made for the division of the $1,500,000 donated by Mr. Carnegie for the erection of this building, and which also explains the organization effected for carrying out the intentions of the donor.

The report of Chairman Charles F. Scott, of the local organization committee, was read by the secretary. There are now thirty local sections where the work of the Institute is followed earnestly.

The report of Chairman W. D. Weaver, of the library committee, was read by Mr. Gano S. Dunn. The library is now valued at $22,000. A number of gifts were received during the year.

Mr. Calvin W. Rice, chairman of the land and building fund committee, reported that this fund has reached the sum of $66,000, two of the recent contributions being $5,000 from Thomas A. Edison, and $5,000 from Dr. M. I. Pupin, the latter being given under the condition that nine other members of the Institute give a similar amount.

The report of the board of examiners was read by the secretary. This suggests that the board of trustees consider establishing a new class of membership, to which associates who have become eminent in their particular field, but who are not practising engineers, shall be eligible.

The financial statement for April, 1905, shows that the cash on hand was $39,301.15, the value of the Institute properties was $44,220.11, making a total of $92,396.89.

A number of other committee reports were presented.

The floor was given to Mr. C. E. Waddell, electrician in charge of the electrical department of the Biltmore estate, Biltmore, N. C., who is chairman of the local reception committee for the annual convention of the Institute, to be held at Asheville, N. C., June 19-23. Mr. Waddell outlined the programme which had been arranged, and urged a full attendance at the convention.

The general subject for discussion for the evening was safety devices. Under this head the following papers were presented: "Relays," by George F. Chellis (associate), instrument tester, Interborough Rapid Transit Company, New York city; "The Proper Limit of Duplication to Secure Reliability of Service," by H. W. Buck (member), electrical engineer, Niagara Falls Power Company, Niagara Falls, N. Y.

The paper by Mr. Chellis, divided relays into three classes: first, differential relays operating at a lower current value when the direction of the flow of energy is reversed than when flowing in its initial direction; second, straight overload relays operating when the current reaches a predetermined limit, irrespective of the direction of flow of energy; third, reverse-current relays, operating when the current reaches a certain predetermined limit upon reversal of the flow of energy. The characteristics and operation of alternator relays and feeder relays were described, and the methods of applying these relays detailed.

Mr. Buck considers that the question of the proper reserve in an electrical installation is a problem that, like many engineering problems, must be settled largely upon the basis of cost. It is nearly always a question involving a balance between the company's obligation to its customers and the obligation to its stockholders. From the standpoint of the consumer, the more reserve, the surer will be his supply of power. On the other hand, to the power company's stockholders, the less the investment in reserve, the larger the dividends, unless the reserve has been cut down to a point where the company's reputation is endangered by interruptions to service. The question is purely a practical one, and no definite laws can be enunciated, nor can any curves be plotted which will indicate the proper amount of reserve to be installed under various conditions. The decision in each case must be based on an intimate knowledge of the local conditions and requirements of the particular installation in question. His paper consisted of a discussion of the general principles involved.

The discussion on the papers was opened by Mr. H. G. Stott, New York city, who differed from Mr. Buck in some points. Mr. Stott said that our present generating stations have reached the very respectable size of 50,000 kilowatts, but there is no reason to hold that this is the final limit. He believes that we will yet go to 100,000 kilowatts. A large station may be just as reliable as a smaller one, particularly with the plan now generally adopted of making each generating unit independent of the others. Mr. Stott said that the danger to underground cables varies inversely as the voltage of transmission, in other words, it is directly proportional to the square of the current, that is with the heating effect. He thinks that we will shortly raise the voltage of transmission by means of underground conductors to 25,000. He recently had occasion to look into the reliability of electric railway operation, and was much surprised to find that, of the total time of interruption, less than one per cent was due to electrical breakdowns, the other ninety-nine per cent being due to causes common to all railway operation.

Mr. Philip Torchio, New York city, explained the system of relays now being used by the New York Edison Company.

Mr. Charles W. Ricker, New York city, gave some interesting experiences of railway operation, and laid stress upon the necessity for protecting all station apparatus, mechanical as well as electrical, against the effects of electrical troubles.

Mr. C. O. Mailloux, New York city, made some interesting remarks upon station protection and operation, as did also Mr. W. S. Wells.

The discussion was closed by Messrs. Chellis and Buck, the latter holding that, while a duplication of plants is more essential for a hydraulic development, in his opinion, two steam plants are better than one.

Lamp Manufacturers' Meeting.

The manufacturers of incandescent lamps operating under the licenses granted by the General Electric Company on its patents, met in quarterly session at Cambridge Springs, Pa., during the last three days of last week.

SCHUYLER SKAATS WHEELER.

PRESIDENT, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Dr. Schuyler Skatts Wheeler, the new president of the American Institute of Electrical Engineers, was born, of Dutch descent, in New York city in 1860. He was educated at Columbia College, being graduated there in 1881. After leaving college, he was employed as assistant electrician in the American branch of the Jablochkoff Electric Light Company. On the dissolution of this company, owing to the failure of the Jablochkoff candle, which was an essential portion of the company's system, Dr. Wheeler took a position with the United States Electric Light Company.

Shortly afterward he became connected with Thomas A. Edison, and it was in this connection that he did his most important early work. At one time he was in charge of the Pearl street station of the New York Edison Company.

Later on, Dr. Wheeler took charge of the installation of a large number of Edison stations in various cities throughout the country. He became superintendent of the Newburgh (N. Y.) Edison Company, after constructing the underground system in that place.

Dr. Wheeler left the Edison company in 1886, and became electrician of the Herzog Teleseme Company. He made many important inventions in this connection. Together with Charles G. Curtis and Francis B. Crocker, he organized the C & C Electric Motor Company, which was the first concern in the United States to manufacture small electric motors. Dr. Wheeler was electrician and factory manager of the new company, and was responsible for most of the features which soon brought the company's motors into prominence.

In 1888 Dr. Wheeler, with his two associates, severed his connection with the C & C company, and Mr. Crocker and Dr. Wheeler formed the firm of Crocker & Wheeler, which later became the Crocker-Wheeler Electric Motor Company. About the time of the formation of the new company, Dr. Wheeler was appointed expert of the Board of Electrical Control, of New York, and performed the duties of that office contemporaneously with the development of the new firm. Shortly after the formation of the Crocker-Wheeler Electric Motor Company, Mr. Crocker was appointed professor of electrical engineering at Columbia University. After his appointment, Dr. Wheeler resigned from the Board of Electrical Control, and gave his entire attention to the new company, of which he was elected president and general manager.

The company was originally located in New York. After about two years, it was reorganized as the Crocker-Wheeler Company of New Jersey, and a large factory was built at Ampere, N. J. The new works were destroyed by fire in 1895, but were immediately rebuilt on a larger scale. The company managed to hold the greater part of its business by installing in tents and temporary sheds large electrically driven tools, and carrying on manufacturing operations during the process of rebuilding. Dr. Wheeler personally supervised the reconstruction of the works, and, on their completion, organized a system of carrying on the business which has proven most successful. This system involves a ledger account of every piece of material, and every finished product which the company uses or manufactures. It also involves the writing of specifications by the draughting department, the issuance of orders and requisitions and by various other departments and a system of receipts and deliveries by the receiving and stock departments. With this system the progress of an order through the shop is rapid and with the minimum amount of friction. It has increased the output, decreased the cost of production and entirely eliminated the necessity of shutdowns for the purpose of inventory.

DR. SCHUYLER SKAATS WHEELER.

Dr. Wheeler is intensely interested in his work, and applies himself to it most closely. He is a man of great force of character, showing a persistent determination to accomplish his ends. This is well illustrated by the methods by which he handled the machinists' strike in 1901, in which the Crocker-Wheeler works were involved.

Five years ago he purchased and presented to the American Institute of Electrical Engineers the Latimer-Clark library, which is said to be the most complete and rare collection of early electrical works in the world. He has contributed on a large number of subjects to the technical journals, and has written, conjointly with Professor Crocker, a book on "The Practical Management of Dynamos and Motors." This book has gone through a number of editions, and has a large circulation.

In 1888 Hobart College conferred on Dr. Wheeler the degree of Doctor of Science. He is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the University and Lotos clubs, of New York, the Chamber of Commerce, of New York, and a large number of other societies.

Dr. Wheeler was untiring in his efforts to secure a permanent home for the American Institute of Electrical Engineers, and he is one of the electrical engineers composing the joint committee for the expenditure of the building fund and the management of the Engineering Building, which is to be the home of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the Engineers' Club.

As president of the American Institute of Electrical Engineers, Dr. Wheeler will bring to this office all the advantages which obtain with the highly trained mind. He is not only a technician of recognized ability, but he has been adequately schooled by long business experience to handle the Institute affairs with precision and directness. He is a fitting successor to the worthy gentlemen who have contributed so wisely and well to the piloting of this most important engineering organization.

National Electric Light Association.

Arrangements have been completed for a special train of Pullman, sleeping, dining, parlor, smoker and observation cars, *via* the Pennsylvania Railroad and the Burlington Railroad, leaving New York at 10.30 A. M., Saturday, June 3, and running as the second section of the Limited, arriving at Chicago at 8.25 A. M., June 4; leaving Chicago 11.15 A. M., and arriving at Denver at 2.30 P. M., June 5.

The convention of the National Electric Light Association holds forth in Denver and Colorado Springs, June 6 to 11.

The Transcontinental Passenger Association has authorized the following rates: from California to Denver and return, one first-class, thirty-day fare. Tickets issued at these rates to be sold *via* usual diverse routes going and returning. The dates of sale are June 2 and 3. The going transit limit to Denver is forty days from date of sale. The stop-over privileges are within the transit limits. For tickets going direct and returning through Portland, $13.50 additional will be charged from San Francisco, Tracy, Lathrop, Stockton, Sacramento, Redding and their intermediates. From points south of San Francisco, Tracy, Lathrop and Stockton, one way local thereto from selling point to be added to $13.50, not to exceed a total addition of twenty-three dollars from Los Angeles or main line points intermediate thereto. From points south of Los Angeles the one-way local thereto to be added to twenty-three dollars, but not to exceed twenty-four dollars from San Bernardino, Colton and Riverside. From Redlands, $24.50 to be added.

In addition to the programme announced last week, the following papers have been arranged for: "Report of the Committee on District Heating," W. H. Blood, Jr.; "Free Signs and Flat Rates," C. W. Lee; "Mercury Arc Rectifier," P. D. Wagoner; "Preliminary Draught for Report of Committee on Rates and Costs," C. L. Edgar, chairman; "A New Type of Single-Phase, Alternating-Current Motor for Elevator Work," S. Percy Cole; "Report on Advertising Methods," Percy Ingalls; "The Paramount Importance of the Selection of Standard in Preference to Special Machinery," David Hall.

Electric Lighting at the Lewis and Clark Exposition.

Electric light is to be used on a large scale at the Lewis and Clark Exposition, Portland, Ore., for decorative effects. A total of over 70,000 incandescent lamps will be used. A feature of the electric illumination will be the electroliers, which will each be made up of a cluster of seventeen fifty-candle-power frosted lamps. The electroliers will be placed on the borders of the sunken gardens of Columbia Court, around which are located all the large buildings. Other electroliers will occupy pedestals on the grand stairway, while the numerous smaller fixtures, each made up of six lights, will be scattered along the walks and through the woods in the western part of the grounds.

The general plan of illumination includes outlining every building by means of eight-candle-power frosted lamps. Four thousand lights will be used on the side of the Agricultural Palace, facing Columbia Court, and 3,000 on the same side of the European Exhibits Building. The dome of the Agricultural Palace will also be lighted by 1,200 frosted lamps. The colonnade entrance will be illuminated by 1,500 lamps. Two towers, located at the ends of the main structure of the Government Building, each 260 feet high, will also be outlined with lamps.

On the bottom of Guilds lake, within the grounds, and on either side of the Bridge of Nations, have been placed rows of fifty-candle-power incandescent lamps. The lamps are enclosed in air and watertight receptacles, and, when lighted, spectators on the bridge will be enabled to see fishes swimming about in the lake. The lake is to be filled with fresh-water fish of many kinds.

Exhibition of Cooking by Electricity.

The New York Edison Company conducted a series of exhibitions of cooking by electricity at its display room, No. 30 West Thirty-second street, New York city, from May 1 to May 13, inclusive. These exhibitions were largely attended by many parties interested in this welcome form of cooking. The cleanliness of the electric system, together with the wide range of the apparatus now fit for service, was highly appreciated by all those who attended these demonstrations.

A Big Chunk of Copper.

A single piece of native copper, weighing 1,000 pounds, will be part of the mining display from Josephine County, Oregon, at the Lewis and Clark Exposition. The chunk of copper was taken from the Golden Standard ledge, the ores of which have been found to assay thirteen dollars a ton in gold and twenty-two dollars in copper.

High-Speed, Long-Distance Electric Traction at the New York Electrical Society.

The 251st meeting of the New York Electrical Society will be held at the American Institute, 19 West Forty-fourth street, New York, Wednesday, May 24, at 8 P. M.

Mr. Charles A. Mudge, formerly chief engineer of the railway department of the Allgemeine Elektricitäts Gesellschaft, Berlin, who took part in the tests on the famous Berlin-Zossen road, will lecture on "High-Speed Long-Distance Electric Traction."

At the juncture when the conversion of steam railroads to electricity is commanding the anxious attention of the mechanical world, this lecture is fraught with unusual importance, and is most timely. The Zossen tests mark the highest point of speed yet attained with locomotives on rails, and point to many of the great problems of the future, as well as their solution. Mr. Mudge's address will be one of the most significant delivered before the society in many years.

The lecture will treat of: the first suggestion of high-speed tests; organization; objects of tests; selection of permanent way; location of road; profile of road; power transmission line; general description of A. E. G. car; summary of tests; first year; second year; third year; illustrated description of apparatus; wiring of car; trolley construction; water rheostat; motor suspension; motor ventilation; truck details; brake arrangements, etc.

Mr. Mudge will conclude the lecture by detailing the bearing of his experience in connection with these tests on the development of high-speed electric railroading abroad.

The Annual Convention of the American Institute of Electrical Engineers.

The annual convention of the American Institute of Electrical Engineers will be held at Asheville, N. C., June 19 to 23. A fine list of papers has been prepared for presentation at this convention. The committee on transportation and arrangements is Frederick C. Bates, chairman, 44 Broad street, New York city; Samuel Sheldon and Arthur Williams.

The passenger department of the Southern Railway has issued a handsome booklet giving complete descriptions and illustrations regarding Asheville and its environment. The scenes along this route are many and of rare beauty. It is expected that the convention will be largely attended, and, in addition to the business sessions, the recreation period can not fail of being most delightful.

Wheel-Pits and Tunnels for Niagara Power.

By Alton D. Adams.

WATER drops into wheel-pits that are nearly as deep as the gorge beneath four of the great power plants at Niagara Falls. Each of these pits has been excavated through alternate layers of limestone and shale, and the rock removed, if it had been carved out as a monolith, would stand far higher in each case than the generating station that now covers its former resting-place.

Each of these pits represents a large volume of excavation, and no small part of the total plant investment, per horse-power or kilowatt of total capacity, but there are striking differences between the pits in these respects.

On the New York side of the river, both of the power plants operating with these deep wheel-pits are owned by the Niagara Power Company, and on the Canadian side, one of the great pits is owned by the Canadian Niagara Power Company, and the other by the Toronto & Niagara Power Company. Over one of the wheel-pits of the Niagara Power Company there are ten generators of 3,750 kilowatts capacity each, aggregating 37,500 kilowatts, or 50,000 horse-power, and over the other wheel-pits there are eleven generators of the capacity just named that aggregate 41,250 kilowatts or 55,000 horse-power. In the plant of the Canadian Niagara Power Company, on the Ontario side of the falls, there will be ten generators of 7,500 kilowatts or 10,000 horse-power capacity each, that aggregate 75,000 kilowatts or 100,000 horse-power. The wheel-pit and power-house of the Toronto & Niagara Power Company are designed for eleven main generators of 8,000 kilowatts each, or an aggregate capacity of 88,000 kilowatts or 117,000 horse-power. Beneath the older station of the Niagara Falls Power Company, in which the ten generators of 50,000 horse-power total capacity are located, the wheel-pit is 424.7 feet long, 18.5 feet wide and 178.5 feet deep. Assuming the power-house floor to be at the natural ground level, as is nearly correct, this wheel-pit required the excavation of about 52,236 cubic yards of rock. Reduced to volume of excavation per unit of power capacity in the electric generators, this older wheel-pit required the removal of 1.04 cubic yards of shale and limestone for each horse-power of capacity, or of 1.39 cubic yards for each kilowatt. Taking the cost of this excavation at $3.50 per cubic yard, which is said to be the going figure for such work about Niagara Falls, the entire investment for digging the pit was $182,826, and this amounts to $3.65 per horse-power, or to $4.87 per kilowatt of generator capacity. In the second wheel-pit of the Niagara Falls Power Company, which is just across its canal from the earlier pit, the dimensions are nearly the same as those above named, but owing to the use of a more compact design for five of the generators in the power-house above, it was found possible to install eleven instead of ten units, and the amount and cost of the excavation per kilowatt was thus reduced about nine per cent.

THE TUNNEL UNDER THE NIAGARA RIVER, TORONTO & NIAGARA POWER COMPANY.

On the Canadian side of the falls a great saving has been effected in the excavation of wheel-pits, through the adoption of electric generators of fully twice the individual capacity of those in the plants of the Niagara Falls Power Company. Beneath the power-house of the Canadian Niagara Power Company the wheel-pit is about 570 feet long, 17.75 feet wide and 162 feet deep below the level of the power-house floor, so that its excavation involved the removal of 60,636 cubic yards of rock, as the power-house floor is near the natural ground level, and there is only a thin layer of earth over the limestone. As the combined capacity of electric generators in this power-house is 75,000 kilowatts, the volume of rock excavated amounts to 0.80 cubic yard per kilowatt or to 0.60 cubic yard per horse-power of their capacity. Taking the cost of this excavation at $3.50 per cubic yard, as before, the investment for this purpose in the wheel-pit of the Canadian Niagara Power Company is $212,226, and this reduces to $2.12 per horse-power, as to $2.82 per kilowatt of generator capacity.

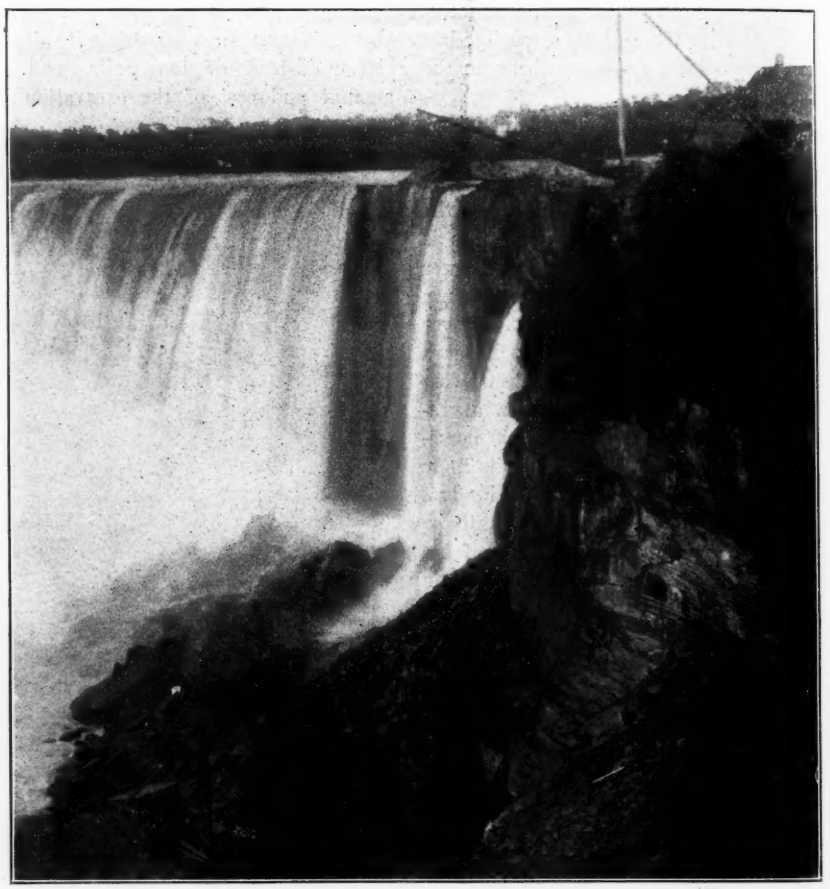
Nearly all of this very large saving in the volume and cost of excavation per unit of power capacity is due to the adoption of 10,000-horse-power generators in the Canadian plant, instead of generators of 5,000-horse-power such as are used in the plants of the Niagara Falls Power Company.

The length of a wheel-pit beneath a given number of vertical direct-connected generators obviously depends on the diameter of each, when located in a single row, and the width of such a pit depends on the diameter of each vertical turbine wheel, which is certain to be less than that of its connected generator. As the diameters of electric generators and of turbine water-wheels increase but slowly with their capacities, a 10,000-horse-power unit requires only a little more

floor and pit area than does a unit of 5,000 horse-power. This fact is very evident on comparing the pit area of 7,857 square feet beneath the 50,000-horse-power plant of the Niagara Falls Power Company with the 10,117 square feet of pit area beneath the plant of the Canadian Niagara Power Company with its capacity of 100,000 horse-power. In the case of the former of these two plants the pit area amounts to 0.157 square foot per horse-power of electric generator capacity, and in the latter case the pit area per horse-power is only 0.101 square foot.

Beneath the floor of the power-house of 117,000-horse-power ultimate capacity, now under construction by the Toronto Niagara Power Company, the pit area is 22 by 416 feet, and the depth is 156 feet. The site of this power-house and wheel-pit was formerly in the bed of Niagara river, so that some filling was necessary, but if the entire depth of the pit had been excavated the volume of rock removed would have been 52,878 cubic yards. It follows that the volume of the pit amounts to 0.60 cubic yard per kilowatt, or 0.45 cubic yard per horse-power of main-generator capacity. At the rate of $3.50 per cubic yard, the cost of excavation for such a pit would be $185,073, and this reduces to $1.58 per horse-power, or to $2.10 per kilowatt of generator capacity above the pit. This pit of the Toronto & Niagara Power Company is thus the smallest and least costly, as that earlier one of the Niagara Falls Power Company is the largest and most expensive of the four great wheel-pits about the falls, in terms of generator capacity. In the earlier pit of the Niagara Falls Power Company, the volume of excavation per unit of power capacity is 2.3 times as great as the corresponding volume in the pit of the Toronto Niagara Power Company, and at the same price of excavation per cubic yard the costs of the pits per unit of power have the same proportion. While most of this great difference in volume and cost is due to the use of generators of 8,000 kilowatts individual capacity over the pit of the Toronto company instead of generators of only 3,750 kilowatts each, as over the pit of the Niagara Falls company, a small part of it results from the greater head of water utilized by the wheels of the former company.

The purpose of each of the four great pits just considered is of course to secure a location for the turbine water-wheels where they can operate under heads approximately equal to the height of Niagara Falls, but the heads actually utilized are not equal. As both of the plants of the Niagara Falls Power Company take water at nearly the same point on its canal, they have a common elevation of head water, which stands normally at 561 feet above tide. In the older of these two plants the centre of the vertical turbine wheels is at elevation 425, and the bottom of the pit at elevation 387 approximately. In this pit therefore the mean head of water above the centre line of the wheels is 136 feet, and the bottom of the pit is 174 feet below the water surface in the canal. The normal elevation of the water surface in this pit, probably when the wheels are operating under full load, is given as about 400 feet above tide, or nearly nineteen feet below the wheel centres. As no draught-tubes are used with these wheels, the head under which they operate is merely 136 feet, the distance between their centre line and the water surface in the canal. Beneath the second power station of the Niagara Falls Power Company the floor of the pit is at the elevation 389 nearly, and the centre line of the wheels is 432.75 feet above tide-water. In this case the turbines are provided with draught-tubes, and therefore operate under the full head of about 161 feet between the surface of the canal and that of the tail-water in the pit. The elevations in this second pit show a distance of 128.25 feet between the canal surface at 561 and the centre-line of the turbines, and a distance of 172 feet from the canal surface to the pit-floor. It thus appears that the turbines in the second pit are located 7.25 feet higher than those in the earlier pit, but that the former operate with a head that is greater by twenty-five feet, if the draught-tubes are able to increase the water pressure by 32.75 feet, which seems hardly probable.



PORTAL OF THE CANADIAN NIAGARA POWER COMPANY TUNNEL, BELOW, AND OF THE SMALL TUNNEL OF THE RAILWAY POWER PLANT, ABOVE.

At the plant of the Canadian Niagara Power Company, the normal elevation of water in the forebay is 516 feet above tide, and the maximum elevation of tail-water in the pit is designed to be 376 feet, thus giving a head of 140 feet for the turbines. These turbines are located with their centre line at elevation 401, and are thus 115 feet below the surface of water in the forebay, so that the draught-tubes must supply a suction equal to twenty-five feet of water pressure in

order to make up the 140 feet of head. In elevation the wheel-pit slopes from 368 feet at its upper to 351 feet at its lower end, and is thus 148 feet to 165 feet below the surface of head-water, and thirty-three to fifty feet below the centre-line of the wheels. With its maximum elevation of 376 feet above tide, the tail-water in the pit has a depth of about eight feet at its upper and twenty-five feet at its lower end.

In the forebay of the Toronto & Niagara Power Company the normal water-level is about 533 feet above tide, and from this elevation there is a drop

Wheel-Pit of the Canadian Niagara Power Company.

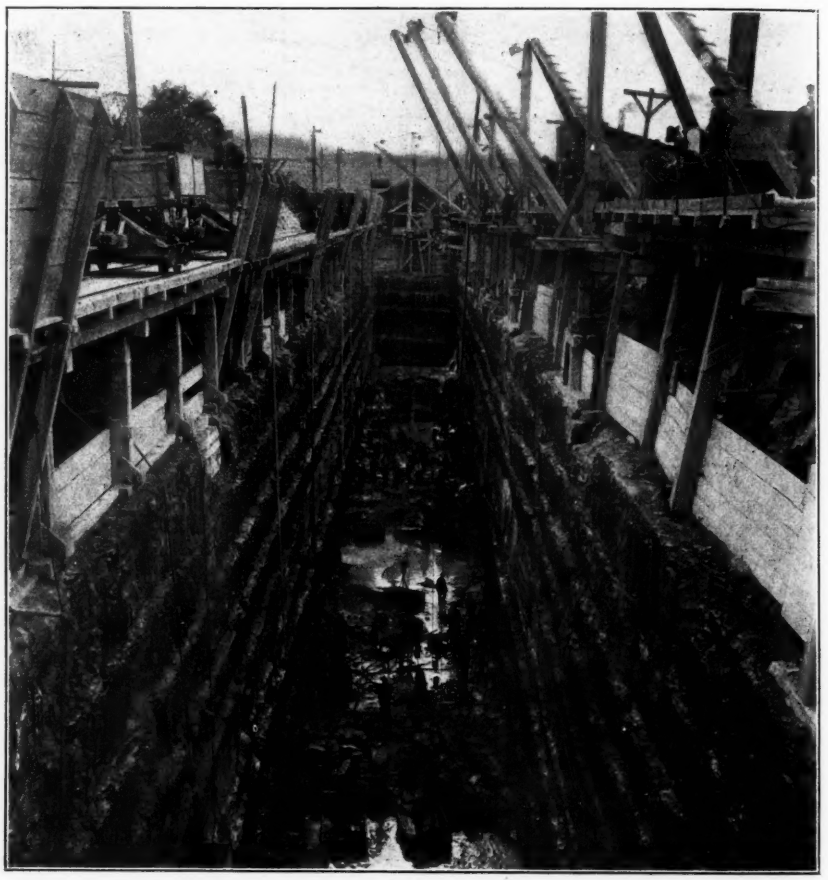
of 145 feet to the floor of the pit. The turbine wheels in this case are set on the solid stone floor of the pit, and they discharge through penstocks into tunnels that run parallel with it on either side. When all of the turbines are in operation at full load, it is estimated that the water surface in these side tunnels will stand at elevation 390, so that the head on the wheels will be 143 feet. The centre-line of the turbines in this pit is at elevation 405.5, or 17.5 feet above the main floor, and 127.5 feet beneath the normal level of water in the forebay. Draught-tubes from the wheel cases enter the side tunnels from underneath, and at one point in the length of each side tunnel its bottom is twenty-five feet below the centre-line of the wheel-cases, so that the suction of the draught-tube represents twenty-five feet of head when the tunnel contains no water. In this case the total head on the wheels increases to 152.5 feet, or about 9.5 feet more than the head when all of the wheels are in operation and the water in the side tunnels rises.

In spite of the different levels of head-water at the four plants above named, that is 561, 533 and 516 feet above tide, which differ by forty-five feet, the heads on the turbines at times of full-load are 136, 161, 140 and 143 feet, respectively, at the four plants. The comparatively low head of 136 feet at the earlier of the two great plants on the New York side of Niagara Falls is due, as already noted, to the absence of draught-tubes. At the second plant of the Niagara Falls Power Company, the head of water on the turbines is 161 feet, or twenty-one feet more than the head on the wheels of the Canadian Niagara Power Company, though the elevation of the head-water level at the forebay of the former company is forty-five feet greater than the like level at the forebay of the latter company. This failure to take full advantage of the greater elevation of head-water, just named, was due to the fact that the plants of the Niagara Falls Power Company are much further from the foot of the falls than is the plant of the Canadian Niagara Power Company, and the tunnel of the former company being the longer has a greater descent. A necessity for a large drop in elevation between the upper and lower ends of the long tunnel of the Niagara Falls Power Company kept the floor of its wheel up to elevation 389 at one point, while the shorter tunnel of the Canadian Niagara Power Company permitted an elevation of 351 feet at the lower end of its wheel-pit.

In three out of four of the above-named pits the tail-water rises when the turbines are in operation, and in order to make these turbines constantly accessible they are necessarily located some feet above

the pit-floor, and are supported on steel beams. The adoption of parallel tunnels on each side of the pit by the Toronto Niagara Power Company makes it possible to erect the turbine wheels on the pit-floor, which remains dry because the tail-water is discharged into the tunnels. By the construction of two side-tunnels, and the discharge of one-half of the turbines into each, it becomes easy to shut down and inspect some of the wheels while others are in use. Another departure from the construction in the other pits was made by the Toronto Niagara Power Company by the use of masonry arches instead of steel cross-beams to support the bearings of each vertical wheel-shaft at intervals as it rises from its turbine to its generators in the power-house above. In the pit of the Toronto company there are two of these masonry arches for each shaft. Immovable as the underlying rock strata of the Niagara region appear, it is interesting to note that there is a constant movement to and fro of the walls of the great power pits above described, and it is necessary to allow for this expansion and contraction of the rock when erecting beams or arches across the pits. Each pit is lined along its sides with walls of pressed brick or other masonry, and these walls in the pit of the Toronto company are two feet thick. Into these lining walls are set the steel cross-beams and masonry arches that support the bearings of each main shaft. At one side of each pit, and at a greater or less distance from the bottom, a pump chamber is excavated in the rock.

After water passes through the turbines it must be conducted into the gorge at the foot of the falls, and this is done by a tunnel from each pit. Both of the great power pits on the New York side of the falls deliver their water to a single tunnel, but each of the two pits on the Canadian side has its own tunnel. The tunnel that connects the two pits of the Niagara Falls Power Company with the lower river is 6,890 feet long between its portal at the river and the wheel-pit of the first power-house. An extension of 546.53 feet carries the original tunnel to the wheel-pit of the second power plant, and gives it a total length of 7,436.53 feet. Along the first 5,000 feet from its portal at the river this tunnel rises at the rate of 0.7 per cent, or thirty-five feet in all, and along the remaining 1,890 feet to the first wheel-pit it rises at the rate of 0.4 per cent, or 7.56 feet in all, so that the total drop in the tunnel between the first wheel-pit and the portal of the tunnel in the gorge is 42.56 feet. The vertical height of this tunnel from floor to roof is twenty-one feet, its width is 18.5 feet, and it is designed to discharge a maximum of 8,600 cubic feet of water per second into the lower river. On the Canadian side of the river, both of the power plants that discharge through tunnels are much nearer to the Horseshoe falls than are the two New York plants above named to the American falls. By way of the river bank, the plant of the Canadian Niagara Power Company is the nearer of the two on that side to the falls. From the lower end of the pit of this company to its portal in the gorge about 400 feet down stream from the foot of Horseshoe falls, the tunnel is 2,200 feet long. The grade of this tunnel is seven feet per 1,000 sloping toward the river, and as the junction of the tunnel and wheel-pit has an elevation of 351 feet above tide-water, the bottom of the tunnel, since it drops 15.4 feet, has an elevation of about 335.6 feet at the portal. In vertical height this tunnel measures twenty-five feet, its maximum width is nineteen feet, and it is designed to pass a maximum of not less than 8,900 cubic feet of water per second. This tunnel, like that on the American side of the falls, is lined throughout its length, and the lining in this case consists of a four-inch layer of vitrified brick backed with eighteen and one-half inches of concrete on the bottom and up to a height of 14.6 feet on each side. The remaining upper part of the tunnel is lined first with a framework of twelve-inch timbers and three-inch lagging, and this is faced with a layer of tunnel brick sixteen and one-half inches thick. For a length of ninety feet just back of its portal this tunnel is lined with granite masonry 2.5 feet thick, and a granite wall two feet thick and sixty feet high is sunk to a depth of thirty feet below the mouth of the tunnel.



THE 137,500-HORSE-POWER WHEEL-PIT OF THE TORONTO & NIAGARA POWER COMPANY.

Though the plant of the Toronto Niagara Power Company is located further up stream than the plant of the Canadian Niagara Power Company, the tunnel of the former company, measured from the lower end of the pit, is a little shorter than that of the latter. Reason for this is found in the fact that the latter tunnel follows approximately the curved river bank to a point in the gorge below the cataract, while the former forms a straight line from its wheel-pit

to a portal behind the Horseshoe falls, and lies entirely under the river bed. This location of the tunnel and its portal is a striking solution of a difficult engineering problem. Measured from the lower or down-stream end of its wheel-pit this tunnel is 2,100 feet long, but at a point 1,935 feet from its portal and 165 feet from the lower end of its pit this tunnel branches into two parts, and one of the two branch tunnels runs parallel with and on each side of the pit. One of the branch tunnels is a little longer than the other, as it receives the discharge of six pairs of turbines while the other branch gets the discharge of only five, and the length of this longer branch above its junction with the main tunnel is about 536 feet. Some distance above their junction point each tunnel is provided with gates, operated from a chamber in the rock above, and when it is desired to inspect one tunnel its gates can be closed so that water from the other will not flow back into it. Each branch tunnel is located with its centre line about thirty-eight feet from that of the wheel-pit. At its portal behind the Horseshoe falls the tunnel has a bottom elevation of 350 feet above tide-water, and about seven feet above the normal level of the basin into which the cataract plunges. Between the junction of the two branch tunnels and the portal behind the falls, a distance of 1,935 feet, the main tunnel drops at the rate of 5.5 feet per 1,000, so that the elevation on the bottom at the point of junction is about 360.6 feet. At points in the branch tunnels in line with the lower end of the wheel-pit the bottom elevation is 364 feet above tide. Over 1,755 feet of its length next above the portal this tunnel measures 26.13 feet high, 17.5 feet wide at the bottom and 23.5 feet in greatest width. In the design this tunnel is to discharge a maximum of 11,200 cubic feet of water per second, and when water is passing through it at this rate the surface level near the lower end of the wheel-pit is expected to be about 382.5 feet. Suspended from the ceiling of this tunnel, and with its footway above the maximum water level therein, there is a steel gallery along which persons may walk from one end to the other. The tunnel is lined with concrete rings, each six feet long, for a distance of 300 feet back from its portal, so that as the face of the cliff behind the cataract wears away the concrete rings will break squarely off and leave a well-defined portal. Save these concrete rings at its lower end, the entire tunnel is lined with two layers of hydraulic pressed brick backed with concrete. In the gorge just below the cataract the water level is subject to large fluctuations, amounting at times to as much as thirty feet. Wheel-pits that are connected by tunnels with the basin below the falls are subject to changes of water-level corresponding in a greater or less degree with those in the lower river, but no water can enter the pit of the Toronto company, though a rise of the tail-water level in the tunnel may reduce the effective head.

All three of the above-named tunnels have cross-sections of nearly the same general form, and the areas of these cross-sections vary nearly as the products of their respective heights and widths. For the tunnel on the New York side of the river the product of height and greatest width, each taken in feet, is 395, for the tunnel of the Canadian Niagara company this product is 475, and for the Toronto company the like product reaches 614. In proportion to their maximum rates of discharge, the tunnels on the Canadian side of the river have thus larger cross-sections than the one on the New York side, and each of the former is only about one-third as long as the latter.

Radiology and Ionization Congress at Liege, Belgium.

Acting Secretary of State Loomis has transmitted to the Secretary of Commerce and Labor a copy of a translation of a note from the minister of Belgium, informing the Department that the first internationl congress for the study of radiology and ionization will be held at Liege from September 12 to 14 next, under the patronage of the Belgium government, and inviting the United States government to be represented at the congress.

The State Department will issue certificates of appointment to any persons whom the Department of Commerce and Labor may nominate as delegates on the part of the United States and who will be willing to attend the congress at their own expense and without compensation from the government.

Members of the teaching corps of the four universities of Belgium and of the military academy are on the committee charged with the organization of the congress. The following is a summary of the programme framed by the committee:

1. Physico-Chemical Section—(*a*) Properties of the electrons and accompanying radiations; X-rays, cathodic rays, ionization; (*b*) radioactivity and corresponding transformations; (*c*) meteorological and terrestrial phenomena connected with ionization and radioactivity; (*d*) N-rays.

2. Biological Section—Physiological properties and medical applications of the various radiations and of radioactivity.

Letters (*a*) and (*b*) include, as particularly interesting points, the examination of terminology relative to the electrons, ions, etc., as well as of the theories concerning the matter and character of the energy. As to the N-rays, they possess points in common with each of the two sections.

Electrical Standards and Units.

At a recent meeting of the Institution of Electrical Engineers, of Great Britain, a discussion took place on electrical units and standards. This was opened by W. Duddell, who described the work of the International Electrical Congress held at St. Louis, Mo., September last, in this connection.

He was followed by various speakers, among them being Lord Rayleigh, who said that there was an unfortunate tendency to take too much for granted in regard to the accuracy of the ohm. If the ohm had been given to us from heaven there would be a good deal to be said in favor of taking the volt as the other standard; but, as things are, the uncertainty there might be about the ohm, and the added uncertainty there might be about the volt, would become unextricably mixed. From the practical point of view much might be said in favor of the Clark cell as a tertiary or working standard, but an eye must be kept on the future, with a view to reducing the uncertainties which exist in this apparatus. Recent improvements in the method of setting up the Clark cell were equally useful for the Weston cell, and the latter presented some distinct advantages over the former. However, until the Weston cell had been watched for many years, and by many observers, it would be unsafe to adopt it.

Professor W. E. Ayrton, in speaking of the doubt which exists with regard to the third decimal figure of the electromotive force of the Clark cell, said that this uncertainty was due mainly to the form of apparatus which has been used in determining it. He thought that a magnetic balance should be used for making this determination. He pointed out that, while it has been shown possible to construct resistance coils agreeing within one part in 100,000, this had nothing to do with determining the exact value of the ohm. He suggested that a redetermination of the ampere be made, and described briefly apparatus which is now being constructed for this purpose.

Dr. R. T. Glazebrook said that the work at St. Louis was to consider the realization of a practical connected series of standards, and did not deal so much with the absolute units. He agreed with Lord Rayleigh as to the undesirability of accepting the volt as a fundamental standard, and that this would involve two possible errors in the determination of unit current. He said that, if the concrete standards now existing in England were universally accepted, and could be

taken as the standards throughout the world, then, for practical purposes, so far as electrical engineers were concerned, the question under discussion would cease to have any very marked interest; but this was not the case. The effort has been made to set up an ampere in Germany, also based on the electrochemical equivalent, but determined under different conditions, and giving, consequently, a different result. The same was true with regard to the standard of electromotive force. The main object of the discussions at the conference which, he hoped, would shortly take place between representatives of the different governments, would be to discuss and secure measurements whereby a uniform set of concrete standards could be established and accepted throughout the world.

Dr. Sylvanus P. Thompson suggested that, in place of the volt or the ampere, the watt or unit of power should be adopted as a standard.

Mr. A. P. Trolter, electrical advisor to the British Board of Trade, said that the order in council of 1894 keeps a clear distinction between a unit and a standard. It says that the "new denominations of standards are required for use in trade based on the following units of electrical measurement." Then follow three paragraphs of definitions. The primary definition of the ohm is 10^9 centimetre-gramme-seconds. The secondary definition—"and is represented by the resistance" of a certain column of mercury. The primary definition of the ampere is one-tenth centimetre-gramme-second. The secondary definition—"and which is represented by the unvarying electric current which," deposits a certain amount of silver per second. The primary definition of the volt is 10^8 centimetre-gramme-seconds. The second definition—"being the electrical pressure that, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere. The third definition—"and which is represented by" the value of the Clark cell. In these three paragraphs the word "standard" is not to be found.

The order in council says that new denominations of standards have been made and verified, and goes on to "approve the several denominations of standards set forth in the schedule hereto as new denominations of standards for electrical measurement." The schedule "set forth" the ohm coil, and does not mention the mercury column; it sets forth the ampere balance, and does not allude to silver deposition, and sets forth the voltmeter without mentioning the Clark cell.

Unlike any other country, the order in council declares the limits of accuracy attainable, and this should be remembered in connection with the words "and is represented," which occur in each definition. The United States law uses the expressions "substantially equal to" and "practically equivalent to." Germany uses the expression "practically equivalent to," and France and Belgium "sufficiently well for practical purposes," and Austria "for commercial purposes."

In 1894 it was necessary to use definitions of the units, but now that so much work has been done on absolute electrical measurements it appears that, if we were starting afresh, the centimetre-gramme-seconds' definition would suffice for the units, and the selection of standards may be left to the officials of each country. Those officials will naturally be in touch with the scientific authorities, and will keep themselves informed about the values of their standards in absolute measure when important absolute redeterminations of the units are made.

Among the many important pieces of work which have been undertaken by the National Physical Laboratory are the absolute determination of the ampere and of the ohm. When the results are declared, the Board of Trade may or may not take official action in declaring a correction or corrections. The result will be so well known to the scientific world that anybody could apply them for himself. At present there is no reason to suppose that the standards of Great Britain differ from the units by more than the limits of accuracy which have been laid down. The mercury column is as good a definition for international purposes as could be devised. The 106.3 centimetres may be revised from time to time as more refined research work is carried out, and the revised figure will indicate the correction to be applied to the standard by those who are engaged in physical work involving absolute measurement. It has been suggested that the method of silver deposition described in the specification attached to the order in council is capable of improvement; for example, that stratification of the solution should be prevented by stirring. But the method of silver deposition is not introduced here for the purpose of defining the ampere by means of the electrochemical equivalent of silver, it is introduced for the purpose of recording the research of Lord Rayleigh who used that particular method. This method formed the link between Lord Rayleigh's work and the ampere standard balance of the Board of Trade. When a new determination is made other links might be devised for scientific purposes, but the precision of the silver deposition is ample for all purposes of trade.

The only part of the work of the committee of 1890 which needs revision is the definition by the Clark cell, and the specification of that cell. "The Board of Trade volt standard" has nothing to do with the Clark cell; it was not verified with reference to that cell, and it is in good working order. Without going outside the Board of Trade electrical standard laboratory, a discrepancy has been discovered between the declared value of the Clark cell and its observed value. He has taken steps to let it be known, semi-officially, that this value appears to be 1.4329 instead of 1.434 at fifteen degrees centigrade, or is 1.434 at fourteen degrees centigrade.

He is not convinced that this discrepancy of 0.788 in 1,000 is of appreciable importance "for use in trade." It is on the limits of practical importance in connection with lamp testing, for it is equivalent to nearly 0.4 of one per cent of candle-power.

The specification of the Clark cell appended to the order in council is now out of date. He can not recommend that form of cell for work of the highest accuracy. He thinks that large cells as suggested by Professor Schuster are better, and it is probable that a Cadmium cell is better still. Knowing the liability of Clark cells to dry up, he would prefer a saturated cell, with a higher temperature coefficient, to a semi-saturated cell with an almost negligible temperature correction.

Experience of the last fifteen years has shown that neither the Clark cell nor any improvement of it is necessary in a standard laboratory as a standard, while, on the other hand, such cells are very valuable pieces of apparatus, both for scientific and for trade purposes.

While he is not prepared to recommend the Board of Trade that any amendment of the order in council is necessary, if an amendment were to be made he would recommend that the definition of the volt should not contain reference to the Clark or to any other standard cell, but that Great Britain should fall into line with Germany, Austria, Belgium and Switzerland.

Professor McClelland has recently shown that the emanation of radioactive substances does not carry an electrical charge, and the same conclusion is arrived at by means of a different form of apparatus by Professor Batlelli, and F. Maccarroul *(Physikalische Zeitschrift, No. 6)*. —*Nature, London.*

NEW YORK ELECTRICAL SOCIETY.

PAPER AND DISCUSSION ON "LIGHTNING PROTECTION FOR HIGH-VOLTAGE CIRCUITS."

The 250th meeting of the New York Electrical Society was held on April 26. Mr. N. J. Neall lectured on "Lightning Protection for High-Voltage Circuits."

Mr. Neall's lecture had for its object a presentation of the possible ways in which this problem might be solved for potentials above 50,000 volts, and reviewed the development of commercial lightning arresters and the study to date of lightning phenomena.

Lightning was considered from the engineering standpoint in its twofold effect: induced charges and direct strokes. To offset the former the first lightning arrester came into existence with the development of the telegraph, and was a simple air-gap between line and ground. The importance of a good ground was early recognized and has always been the *sine quo non* of such protection.

Power transmission later brought the need of suppressing a short-circuit arc at the time of discharge over these gaps between line and ground; in order to accomplish this nearly every known scientific means of extinguishing an arc has been carried into a patent.

Besides lightning arresters, the choke coil came early into use, although its function was not at first fully appreciated. This type of protection has developed as follows: first, used as an integral part of the lightning arrester; Wurts pyramidal form; multispark coil; compensated coil; static interrupters; single coil; Elihu Thomson's skin effect arrester; "Gola" lightning arrester.

After a discussion of these features, it was shown that little has been accomplished in the way of protecting against direct stroke, although overhead grounded wires have been proposed and metal towers are expected to do some good. Wood poles have been badly shattered, but owing to short wire suspensions the service has not been seriously impaired.

The scientific investigation of lightning phenomena has been greatly neglected, little having been done since the work of Franklin, Shaffner and Lodge. The present problem calls for a careful study of all such phenomena and their effect on transmission lines. The general conditions have been sufficiently well understood to enable arrester design to advance. Lightning, however, can not be studied directly at any and all times, and to enable commercial development of protective apparatus it must be studied by imitation of service conditions.

A method of this kind whose value has been highly commended is the equivalent spark-gap method, which was first used by Wurts, and later developed by Thomas.

Slides were shown giving the comparative value of lightning arresters based on this test, as well as the protective power afforded by choke coils to transformers. From this was reduced the law of protection: "complete lightning protection must consist of a choke coil and lightning arrester; the former to have a high equivalent spark-gap, the latter a low one."

Mr. Neall held that neither through commercial development nor through scientific study of lightning phenomena has anything yet developed to give an arrester with an air-gap lower than that of air for the normal voltage for a static disturbance and greater for the current which tends to follow. Many styles will fail from inherent weaknesses of mechanical development. The existing types have already divided themselves into those for low voltage and those for high voltage. Many of the inventions in lightning arresters are highly scientific in theory, but toys in development. The principal need at the present time is clearly for a quantitative as well as for a qualitative development. The possible ways in which the problem may be solved rest on the fact that the disturbing conditions are electromagnetic and electrostatic.

In choke coil protection we already have a final form—a spiral or simple construction, its insulation and strength depending on given conditions.

The lightning arrester on account of possible reduction of short-circuits, grounds, etc., to a minimum, will be reduced to taking care of induced lightning discharges.

The winding type must be simple in form and construction, and may be based on the principle of the horn arrester.

The effect of electric inductance and skin effect in modern work was discussed, showing the great part this plays, not only in all types of resistance, but in the transmission line itself. The freedom of disturbance from static discharges, said to exist in California, may arise from this skin effect of the wires themselves in holding back discharges of the capacity of the line.

For direct strokes metal towers and lightning rods may be employed.

For high-voltage direct current, say 70,000 volts, as was experimentally tried in Switzerland a short time ago, there would be no difference in the lightning protection required, excepting that the multi-gap type will be thereby cut out and the final type of arrester would be based on the horn and coherer principles.

Uninterrupted service will be more and more an important requirement in this development. short-circuits of even two seconds being objectionable.

In general the problem may be said to be far from solution, the natural development of transmission work having exceeded that in lightning arresting. The workers in the field are few in number and their efforts are not united. Much has been done by the large manufacturing companies, but much can also be done by practical men as well as by the scientists; the large number of technically trained men now in the field should exercise an appreciable influence on this investigation. The equivalent spark-gap method offers a means limited only by cost for meeting fully the commercial development involved in this problem.

A number of slides were shown of such arresters as are in commercial use to-day with an explanation of the carrying out of the principles involved in their construction.

DISCUSSION.

H. C. WIRT: I will have to take exception to some of the suggestions made by the lecturer. I believe that a static machine test or inductorium test should not be considered as entirely proving whether an arrester is effective or not; the real test comes when the lightning arresters are placed on the line and observations made in actual practice. Even reports received from service conditions have to be considered very carefully.

It is probable that the design of high-tension arrester will have to be materially modified. A desirable form of arrester will be one that is simple in construction and takes up a small amount of room in the station. At present they all are built on very much the same principles, as they all have series resistance in one form or another. The horn arrester that the lecturer has mentioned, when carefully examined, is seen to be very similar to arresters made in this country. In the latter the arc is divided by small gaps with resistance in series with them, and in the horn arrester we have a single gap. Comparative tests have shown that a higher resistance is required to break the arc with a single gap than with multiple gap, so it is difficult to see any advantage in the horn arrester.

Regarding the use of devices to keep down the pressure between wires, there is no question but what such devices are necessary. Examination of a large number of standard low-voltage transformers, 2,000-volt primary, has shown that these rarely burn out between primary and secondary, but that the outside layers of the primary from line to line burn out; and the remedy for this is to place a spark-gap across the connection board of transformer, which will short-circuit when high-potential exists between line and line, causing the fuses to blow. One hundred and fifty of

these transformers are now being tested in actual service conditions.

F. W. JONES: Prior to 1880, the telegraph electricians were able to successfully cope with all ordinary lightning discharges to prevent their harmful effect upon electrical apparatus in telegraph stations. The method that was found to be economical and efficient was what is known as the plate arrester, which consisted of a small brass plate having a surface of about six square inches separated from a similar ground plate by a sheet of mica which had been perforated by a few small holes. The thickness of this mica was adjusted to prevent the current used for telegraph purposes from jumping across from the line-plate to the earth.

For the protection of telegraph poles out in the open country a length of telegraph wire was run from a coil of the wire placed under the foot of a pole up the side of the pole through staples terminating about three inches above the top of the pole. Since 1880, after the introduction of overhead electric light and power wires which form a network under and over telegraph wires throughout the country, the telegraph company was compelled to increase the space between the line-plate and the ground-plate to such a distance that the high-voltage currents from electric light and power wires would find it impossible to jump across the space between the plates and so result in a destructive arc. These arresters are used at intermediate and other stations that are closed for the night, but a more sensitive arrester having a space of only ten mils is used at our large terminal stations which are kept open during the twenty-four hours. At these stations, besides the sensitive arresters, there are employed cartridge fuses which are regulated to blow at one-half ampere at seventy degrees in about thirty seconds, but at all intermediate offices that close for the night it is found necessary to use cartridge fuses which do not blow under twenty amperes, for the reason that lightning would be constantly opening sensitive fuses and deprive the company of the use of the wires until the operator arrived at the office in the morning. In all such offices, the instruments are kept cut out of the circuit when not required for use, and in the instrument circuits there are as sensitive fuses and arresters as the signaling currents will permit.

During the lightning season in the Far West, our overland Pacific lines are occasionally interrupted by lightning cutting the hard-drawn copper wires between the poles, the same as if cut by pliers, excepting that the ends of the wires are melted to points, and the wires, sometimes for two or three inches, on both sides of the cut have very fine globules of copper adhering longitudinally in a row on the underside. Lightning rods have been erected upon every fifth pole.

The Postal Telegraph company recognizes the importance of a good earth in the rules which are contained in its book of rules governing the "Wiring of Offices."

H. L. CARPENTER: From the telephonic standpoint, lightning protection presents a number of interesting points. Telephone apparatus in general is of a most delicate and highly inductive nature. The great number and extent of telephone lines, the general character and location of the equipment, and the nature of the service given with it, require that adequate protection against any high-potential discharges be provided. The extremely low potentials and currents carried over normal telephone lines mean that very little stress need be given to the dissipation of telephone-current arcs, which is apparently the most important element of high-tension lightning protection.

Very much as Mr. Jones has just mentioned, aside from lightning discharges, it is essential to provide means to dissipate any unfriendly currents traversing along telephone lines, due to crosses with other high-tension power circuits. If we find any stray heavy currents on telephone lines, we wish to get rid of them as rapidly and completely as possible, rather than keep them with us.

Experience has proven that the most prominent source of complaint resulting from high-tension charges on telephone lines is the breaking down of apparatus due to induced lightning discharges. It is not an infrequent occurrence in outlying districts where aerial lines predominate for a single lightning discharge, which perhaps does not strike any telephone lines, to produce inductive charges on several hundred telephone circuits. If it were not for the individual lightning arrester protection on these lines great damage to apparatus would result. With the protection, the discharges all pass to ground, with perhaps the only bad result of a few grounded lines caused by loosened carbon dust bridged across the small air-gaps of the lightning arresters.

A somewhat new phase to the question of telephone-line protection is being introduced by the development of the loaded aerial toll-line circuits. These circuits, as is probably generally known, are of a highly inductive nature, the individual loaded sections being practically isolated inductively from other sections when considering high-frequency lightning discharges. Where these loaded lines leave aerial circuits to enter underground cables, I believe special choke coils are being considered, if not in some cases already provided.

RALPH D. MERSHON: I agree with Mr. Wurts that the spark-gap method of comparing lightning arresters is not a reliable one. I think that at best it is a very rough measure of the ability of the lightning arresters to afford the easy path for lightning discharges. I think that by making use of such a method of test almost any result desired could be obtained by properly varying the frequency of the discharging current. If it were possible to know what the frequency of the lightning discharge would be and such a frequency were used in the measurement, then the comparative method Mr. Neall describes might be satisfactory, but under any other conditions it seems to me that it is open to question.

So far as I can see now, there is every evidence that for the higher voltages at least lightning protection will be much simpler than at present.

I am inclined to think that the trouble with most of the high-voltage arresters is that of too high an inductance in the arresters themselves. It does not do much good to make use of choke coils and other elaborate devices for "piling up potential," if after the potential is "piled" the lightning arrester can not take care of it, and I believe that most of the lightning arresters, as now constructed, are faulty principally because of the fact that their inductance is too high to allow the lightning discharge to readily pass.

J. L. STREEVER: My experience in the matter of the effect of lightning on transformers has been of a practical rather than laboratory character.

I noticed several years ago that a direct stroke of lightning which would leave an iron smokestack and choose a path to ground *via* a guy wire attached to a yellow pine guy-stub or one that would splinter a new chestnut pole into kindling wood and completely ignore a set of approved arresters installed on the same pole and grounded to a water main, was beyond the control of any apparatus on the market.

I also observed that on circuits strung through sections where there were a great many trees and where numerous tree-grounds were practically unavoidable in wet weather and where it might be assumed that any static charge on the lines would be promptly dissipated, the damage to transformers was as great, if not greater, than on circuits that were known to be free from contact with anything but the glass insulators.

It also appeared to me that the current induced into the lines by a lightning discharge in the vicinity had a decided inclination to cross over from one wire to the other and found an easier path through the transformers than by traversing the two sets of air-gaps in the arresters.

In most cases the ensuing short-circuit destroyed the evidence desired as to the exact course taken by the discharge through the transformer which could not have been by following the windings on account of the choking effect, but rather by bolting across *via* the points of least resistance; in some instances where the case was quite full of oil the transformer showed little damage except that the gases generated smashed the cover.

The facts noted led to the conclusion that one feature of the problem might be solved by providing an easy and safe path by means of which the difference in stress on parallel wires might be equalized.

Acting on this assumption, during the summer of 1904 we installed a number of six-gap arresters directly across the lines with a primary cutout and a five-ampere fuse in series; every arrester so installed gave evidence of having performed the work intended and in only one instance was a fuse blown; the results were so satisfactory that the scheme will be tried on a larger scale this season.

THE ALUMINUM ELECTROLYTIC CONDENSER.[1]

BY CLARENCE IRVING ZIMMERMAN.

"The Aluminum Electrolytic Condenser" was the subject of a paper by the writer at a former meeting of this society.[2] The peculiar condenser behavior of a cell consisting of two similar asymmetrical conductors was analyzed and discussed. It was shown that the aluminum cell approximated these conditions.

In connection with these points it was mentioned that the film coating the aluminum electrodes has a thickness of from less than 0.000005 centimetre to, in exceptional cases, more than 0.000050 centimetre. This result was arrived at by observing the interference colors presented. The films are too thin to be measured with a high power microscope. It was shown that under some conditions

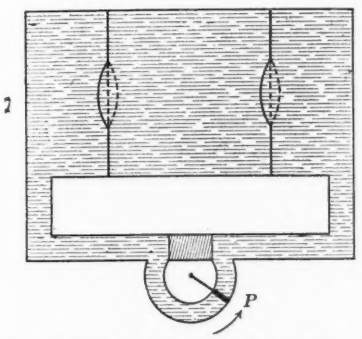


FIG. 1.—REPRESENTATION OF TWO TINFOIL CONDENSERS IN SERIES.

the film may have a very high disruptive strength. The various sources of energy losses were discussed, and it was stated that 110-volt condensers having efficiencies[3] of over ninety-five per cent had been made. Comparisons with tinfoil condensers were made.

This paper is a continuation of the previous one. There will be presented some additional information and data relating to the above points, together with a discussion of unsymmetrical condensers and polyphase condensers.

HYDRAULIC ANALOGY OF THE ALUMINUM ELECTROLYTIC CONDENSER.[4]

A clearer conception of the behavior of the aluminum condenser may perhaps be obtained by comparing the electrical circuits and pressures to hydraulic circuits and pressures moving back and forth in the hydraulic circuit. The tension in the membrane corresponds to the potential of the electrostatic coulomb charge in the film. The space traversed by the membrane from the position of minimum surface represents the coulomb charge.

In Fig. 1 two tinfoil condensers are represented in series connection. P is a pump, which by some external means causes the liquid contained in the vessel to move back and forth and thus sets up displacements of the two elastic membranes, first in one direction and then in the other.

In Fig. 2 the aluminum condenser films or dielectrics are represented by a combination of membranes and valves. The latter allow the liquid to flow out from the middle compartment (the electrolyte), but not into it. An examination of the tensions that must exist in the membranes will make it clear that both valves remain closed after one of the membranes has been stretched to its maximum value, no matter what lower pressure exists subsequently in the outer compartments. The instant of maximum tension in the membranes corresponds in the aluminum condenser to the instant of maximum impressed pressure. The membranes are stretched alternately, but always toward the middle compartment. The middle compartment (the electrolyte) thus remains under a lower pressure than the outer compartments (the electrodes and the electrical circuit as a whole).

RESISTANCE, DIELECTRIC STRENGTH AND INDUCTIVITY OF FILM.

The values the author gives below for the resistance, dielectric strength and inductivity are merely approximations, due to the method employed in measuring the thickness. The statements made in regard to these points in the previous paper were based upon similar calculations. Mott calculates the specific resistance of the film (as an anode film) to be of the same order as other solid dielectrics.[1] He gives an example of a certain film whose specific resistance was 10^{11} ohms per cubic centimetre. While this is somewhat lower than that of good dry insulators, the author agrees with the same general conclusions if it be assumed that the leakage current is due more to the disruption of the film than to the uniform conduction of the observed current flow. The figures below give an example of results which the author has obtained with a certain film 0.000075 centimetre thick:

Aluminum anode, eight centimetres by twelve and one-half centimetres; area of anode, 200 square centimetres; electrolyte, nearly neutral solution of

$$(NH_4)_2C_4H_4O_6 + KNaC_4H_4O_6$$

saturated; thickness of film, 0.000075 centimetre; pressure on film, 100 volts; current flowing, 0.002 ampere; hence, specific resistance (resistance per cubic centimetre) equals 1.33 by 10^{11} ohms per cubic centimetre.

DIELECTRIC STRENGTH.

In the previous paper it was stated that the dielectric strength was apparently greater than that of mica. The dielectric strength, as calculated by the author, of numerous films upon which various pressures up to 500 volts were impressed, gives results a little higher

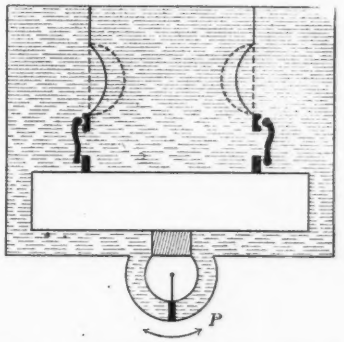


FIG. 2.—REPRESENTATION OF ALUMINUM CONDENSER FILMS.

than that of 1,000,000 volts per centimetre obtained by Mott.[1]

The results below indicate the values obtained:

Volts Withstood.	Thickness in Centimetres.	Dielectric Strength in Volts per Centimetres.
360+	0.000060	6,000,000+
100+	0.000020	5,000,000+
150+	0.000030	5,000,000+

The dielectric strength of mica has been recently calculated to be between 1,000,000 and 2,000,000 volts per centimetre for a thickness of 0.01 centimetre.[2] Steinmetz gives the gradient of 4,000,000 volts per centimetre for mica at zero thickness.[3]

INDUCTIVITY OF FILM.

That the inductivity of the film is apparently high for a solid is indicated by the measurements and calculations below. The author has not attained as high

[1] Abstract of a paper read at the seventh general meeting of the American Electrochemical Society, Boston, Mass., April 25, 1905.

[2] "The Aluminum Electrolytic Condenser," Trans. A. E. S., April 9, 1904. Vol. v, p. 147.

[3] By "efficiency" is meant the ratio of volts × amperes divided by volts × amperes plus losses.—Report of A. I. E. E Committee on Standardization, 1898—Appendix i.

[4] ELECTRICAL REVIEW (N. Y.), vol. xliv, No. 18, 4-30-'04.

[1] *Electrochemical Industries*, vol. ii, No. 9, September, 1904.

[1] *Electrochemical Industries*, vol. ii, No. 9, September, 1904.

[2] *Electrician* (London), December 19, 1904.

[3] Trans. A. I. E. E., February, 1893.

a figure as eighty, as might possibly have been inferred from the previous paper.[1]

The formula for the capacity of a cell in microfarads is

$$C = \frac{K}{900000} \times \frac{S}{4\pi d}$$

where C = capacity of cell in microfarads.

K = inductivity (specific inductive capacity or dielectric constant).

S = area of dielectric in square centimetres.

d = thickness of dielectric in centimetres.

By substituting the values of C, S and d obtained from an aluminum condenser, we may obtain K, the inductivity,

C = 220 microfarads.

S = 5,110 square centimetres.

d = 0.000030 centimetre.

From which the inductivity

K = 14.6.

CELL LOSSES.

It was stated in the previous paper that the cell losses consist of (1) film losses,

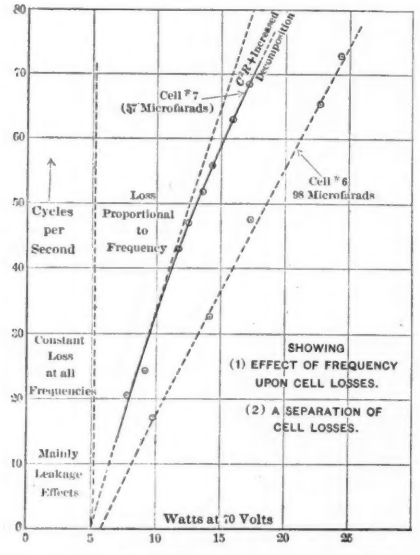


FIG. 3.—GRAPHIC REPRESENTATION OF CELL LOSSES.

(2) I^2R losses, and (3) electrolytic decomposition losses; and that the film losses (1) consist of (*a*) leakage through film and (*b*) losses proportional to the frequency. The latter are in general larger than the other losses in the cell and are of a nature not clearly understood. A crude graphical representation of these losses is given in Fig. 3, where there is plotted a curve between watts and frequency. The observations were made upon two cells in which the electrolyte consisted of an aqueous solution of commercial borax. All the losses were increased considerably by this impure electrolyte. The separate losses are graphically shown.[1]

That these losses can be reduced is evident from the figures on other cells made by the author, shown in the table below:

Capacity of Cell in Microfarads.	Pressure on Cell (60 Volts.)	Watts Lost.	Current Flow.	Efficiency.
40	110	8	1 65	96.2
40	80	3	1.21	97.0
58	110	14	2.41	94.9
58	80	6	1.74	95.9

The power measurements were made with sinusoidal waves and with carefully calibrated non-inductive watt dynamometer of the Siemens type. The current was measured with a Kelvin balance.

EFFECT OF FREQUENCY ON CHARGING CURRENT.

The condenser charging current varies in proportion to the frequency where the impressed pressure is kept constant and the frequency varied. At low frequencies, however, the watt consumption shows a slight deviation from a straight line law, due to the predominating effect of the leakage current. At the higher frequencies, the capacity component practically suppresses the power component.

ALTERNATING AND UNIDIRECTIONAL PRESSURES IN THE SYMMETRICAL CELL.

In the previous paper it was shown that the theoretical ratio of the alternating pressure (E) impressed upon the cell terminals to the unidirectional pressure between the electrolyte and a point neutral to the alternating pressure is equal to the impressed pressure (E) divided by $\sqrt{2}$. The actual values obtained are smaller than these, due chiefly to the imperfect asymmetry and partially to the cell resistance, to film leakage, and to polarization pressures.

Fig. 4 shows the relations existing in a cell, each of whose plates had a capacity of 114 microfarads. The electrolyte consisted of a saturated solution of borax with a small amount of glycerine added. The curve is practically a straight line above ten volts alternating pressure. Below this point, the unidirectional pressures keep close to the zero value, owing to the slight asymmetrical effect of the film at such low values and to the polarization pressures between the aluminum and the carbon. If the straight part of this curve be projected until it crosses the horizontal line representing the zero of alternating pressure, the unidirectional value is 4.5 volts. Part of this pressure is probably produced by the chain aluminum = electrolyte = carbon. The dotted line in the diagram represents the theoretical relation based upon the assumption that there is perfect asymmetry, that there are no polarization pressures, and that the losses in the cell are zero.

These pressure relations do not materially vary with any small change in frequency, and since such a cell can be easily set up, this scheme may be used for the purpose of calibrating alternating pressure instruments where extreme accuracy is not desired. For the purpose of calibration, it is only necessary to connect the alternating-current instruments across the cell terminals and the direct-current instruments between an auxiliary carbon electrode (electrolyte) and one of the aluminum electrodes.

UNSYMMETRICAL CONDENSER.[1]

By the term unsymmetrical condenser is meant a cell having two electrodes with different electrostatic capacities. For example, we may have two plates of the same size but having different film thicknesses, or we may have electrodes of different sizes but having the same film thickness, or we may have a combination of these two cases.

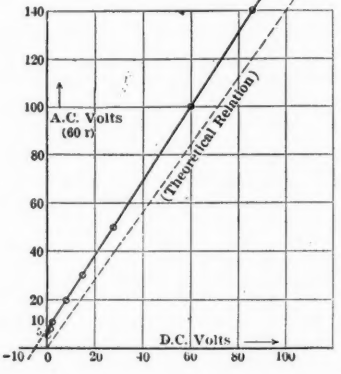


FIG. 4.—RELATIONS EXISTING IN A CELL WITH PLATES OF 114 MICROFARADS CAPACITY.

The limiting case of an unsymmetrical condenser consists of one large electrode and an aluminum point for the small electrode. All other unsymmetrical cells may be considered to be some stage between the symmetrical and the limiting case of unsymmetrical cells.

In studying the unsymmetrical cell we have the same general rules to follow as in the symmetrical cell, namely, that the con-

[1] Trans. A. E. S., vol. v, 1004, p. 149.

[1] While the values of the frequency and the power were plotted from careful measurements on a certain low efficiency cell, the exact limits of the shading as shown in the figure are to be considered only as an aid to a clear understanding and not as an accurate separation of them.

[1] The term "unsymmetrical condenser" should not be confused with the term "asymmetrical cell." The latter designates an electrolytic cell composed of an electrolyte in which there is one electrode coated with a film, and one electrode which is incapable of producing an insulating film.

denser behaves on an alternating-current circuit like two tinfoil condensers having capacities corresponding to those of each of the aluminum electrodes, and that there is automatically stored up in the cell a constant coulomb charge. This charge distributes itself in the cell according to the direction and value of the externally impressed pressure.

The effects of this constant coulomb charge in a symmetrical cell consisting of two similar electrodes of aluminum immersed in an electrolyte were given in a previous paper before this society.

In an unsymmetrical cell it can be shown that the coulomb charge in the cell is independent of the electrostatic capacity of the smaller electrode. It is equal to the maximum charge held by the larger electrode. In Fig. 5 is shown an unsymmetrical cell consisting of two aluminum electrodes, *'a'* and *'b'* immersed in an electrolyte, the potential of which can be measured by means of a carbon rod *c* immersed in it; *a* represents the small electrode and *b* the large electrode. Suppose the pressure in the circuit is such that the large electrode *b* is becoming

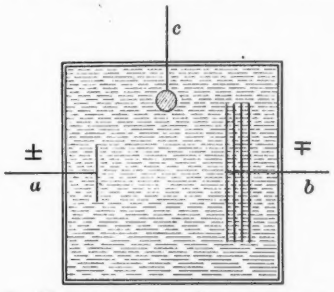


FIG. 5.—UNSYMMETRICAL CELL CONSISTING OF TWO ALUMINUM ELECTRODES.

positive to the small electrode *a*, being an anode, the film of the large electrode acts as a non-conductor. A momentary flow of current occurs while its film receives an electrostatic charge. This charge is positive on the side of the film in contact with the metal and negative on the side in contact with the electrolyte. The temporary current flow finds a ready path out of the cell since the small electrode *a* allows passage in that direction. When the impressed pressure reaches its maximum value the large film becomes charged to its full extent. (This is equal to $c_1 E_m$; where c_1 is the electrostatic capacity of the large plate and E_m is the maximum value of the alternating pressure impressed upon the cell.) When the pressure decreases the charge has to remain on the large plate because the electrostatic capacity of the small electrode is negligible and upon the reversal of the current the small electrode quickly becomes charged to its full pressure, thereby stopping the current. When the pressure reaches its maximum value in the direction opposite to that we assumed at the start, the pressure on the large film and the impressed pressure act in series. Thus the pressure between the small electrode and the electrolyte reaches a theoretical maximum value of twice the maximum value of the pressure of the alternating wave upon the cell. In actual cells I have calculated that instantaneous pressures of 250 volts were reached with a maximum of 141 volts impressed upon the cell terminals. These calculations were based on measurements given in the table below.

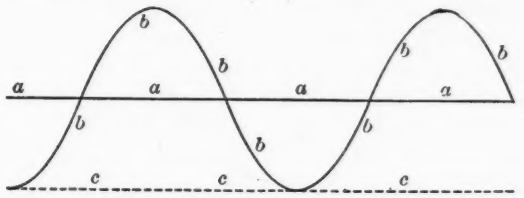


FIG. 6.—GRAPHIC REPRESENTATION OF ATTAINMENT OF MAXIMUM PRESSURE IN CELL.

This interesting point is shown graphically in Fig. 6, where *b-b* represents the potential of the large electrode, taken for reference; *a-a* is the potential of the small electrode with respect to the large one; that is, it represents the impressed pressure; *c-c* represents the potential of the electrolyte which, as we observed before, must remain negative to and at a constant potential difference from the large electrode. The pressure between the small electrode *a-a* and the electrolyte *c-c* is represented by the ordinates between the corresponding curves in Fig. 6.

In Fig. 7 is an hydraulic analogy of the unsymmetrical cell. With the previous hydraulic analogies in mind, this diagram is self-explanatory.

Measurements which have been made on various cells approaching the limiting case are given in the accompanying table. They do not reach the limiting theoretical

PRESSURES OBSERVED IN VARIOUS UNSYMMETRICAL CONDENSERS.

(A) Capacity of Large Condenser Plate.	(B) Impressed A. C. Pressure.	(C) A. C. Vm. Pressure on Large Plate.	(D) D. C. Vm. Pressure on Large Plate.	(E) A. C. Vm. Pressure on Small Plate.	(F) D. C. Vm. Pressure on Small Plate.
(1) 8 mf.	88.0	85	97.0	121.5	96.5
(2) 8 mf.	71.0	68	78.5	92.5	78.0
(3) 12 mf.	103.0	110	111.0	144 0	110.0
(4) 12 mf.	102.0	104	102.0	143.0	105.0
(5) 12 mf.	51.0	60	56.5	....	....
	50.5	....	....	79.5	57.0

values, because (1) the small electrode in some cases had a capacity of several microfarads; (2) the measuring instruments absorb some of the charge; (3) there are cell losses; and (4) the film is not a perfect asymmetrical dielectric. These readings were obtained with various cells at different times and with different electrolytes.

It will be observed that the pressure in the twelve microfarad cells in columns C and D and in D and F are nearly the same, showing, first, that the pressure on the large electrode is a nearly uniform unidirectional pressure, and second, that the average pressures on the two plates are the same.

MATHEMATICAL ANALYSIS OF CELL.

The fundamental equations of the aluminum condenser differ from the corresponding equations of two tinfoil condensers in the two following points:

(1) The pressures on the two aluminum films are in opposition to one another, while the pressures on the tinfoil condenser dielectrics act in unison.

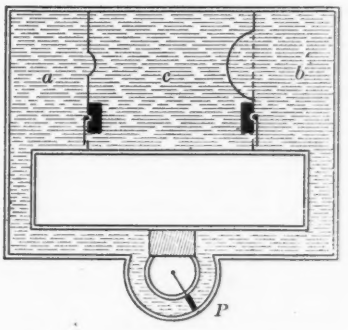


FIG. 7.—HYDRAULIC ANALOGY OF UNSYMMETRICAL CELL.

(2) The sum of all the coulomb charges in the aluminum cell is constant and is equal to the maximum charge capable of being held on one electrode in the cell. In the tinfoil condensers the coulomb charge varies with the pressure on the terminals.

The "equivalent" capacity of an aluminum cell is $\frac{c_1 c_2}{c_1 + c_2}$, where c_1 and c^2 are to electrostatic capacities of the two dielectrics. This ratio is also the equivalent capacity of two tinfoil condensers operating in series, the condensers having capacities c_1 and c_2. On an alternating pressure circuit a condenser composed of two asymmetrical electrodes acts like

two tinfoil condensers connected in series, having equivalent electrostatic capacities. The internal conditions, however, are quite different.

POLYPHASE CELLS.

In the polyphase condensers the same general rules that apply to single-phase condensers hold good, but some additional points relative to them will be mentioned. On a two-phase independent four-wire circuit an aluminum condenser consisting of four plates immersed in the same electrolyte may be used. Neither circuit will interfere with the other.

On a three-wire two-phase circuit a three-plate single-cell condenser causes a charging current to flow not only in the two phases, but in the phase formed by the two independent wires of the three-wire system. The pressure between these two wires is considerably greater than the pressure of the normal phase. Because of this extra wattless current such a cell might be objectionable on a two-phase three-wire circuit.

In a three-phase condenser consisting of three similar plates in a single cell, we have an interesting problem for solution. The properties of this cell are briefly summarized below.

The sum of the coulomb charges on the three plates is constant, and is equal to the maximum charge capable of being held by the cell with a given impressed pressure.

This maximum charge does not collect at a time when the pressure across two of the plates is a maximum, as it does in the single-phase condenser. It collects when two of the three plates are at an equal positive potential with respect to the third plate. This point is shown in Fig. 8, at the point 0-0. The constant coulomb charge is equal to $(2\,c)\,\sqrt{3}\,/\,\sqrt{2}$ E, where c is equal to the electrostatic capacity of one of the three similar plates and E is the delta alternating-current pressure impressed upon the cell.

This coulomb charge theoretically sets up a constant unidirectional pressure between the electrolyte and the neutral point of the three-phase circuit. This pressure is equal to the maximum value of the star voltage of the circuit or its equivalent.

If one of the three electrodes be disconnected from the circuit, the constant unidirectional pressure drops to the normal single-phase value. This is equal to $\frac{1}{\sqrt{2}}$ E, or 0.707 times the impressed delta pressure.

The total energy stored in the condenser is constant at all times, and is equal to $(3/2)\ C\ E^2$, where C is the capacity of one of the plates and E is the delta pressure impressed upon the cell.

The figures below are actual measurements made upon a three-phase aluminum condenser. The observed voltages are somewhat lower than the theoretical voltages.

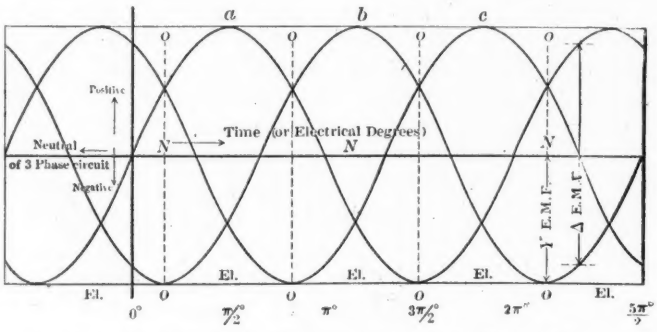


FIG. 8.—DIAGRAM OF PRESSURES IN A THREE-PHASE CELL.

THREE-PHASE CONDENSER PRESSURES.

	Phase.	Volts.
Impressed pressure (delta voltage)	1	108
	2	107
	3	108
Constant unidirectional pressure to neutral point		81
Theoretical value to neutral point		92.5
Pressure with one of the electrodes disconnected		68
Theoretical value		79

ROTATING CHARGE.

An interesting point in connection with polyphase cells is that one may arrange the electrodes in a circle in the electrolyte and produce a rotating negative electrostatic charge in the electrolyte. In the single-phase condenser it was pointed out previously that the negative charge may be considered to be sent back and forth from one electrode to the other.

In Fig. 8 is shown a diagram of the pressures in a three-phase cell. The zero line represents the potential of the "neutral" point of the three-phase circuit. The sinusoidal curves represent the potentials of the three electrodes with respect to the neutral point. The potential of the electrolyte is represented by the straight line E1-E1. Losses in the cell due to leakage are intermittently supplied near the nodes *o-o, o-o, o-o,* where two of the plates are positive to the third.

The equivalent capacity for each phase of a three-phase condenser such as is discussed is one-half the capacity of one electrode.

STREET LIGHTING IN NEW ENGLAND.

THE SUCCESSFUL ADAPTATION OF NERNST LAMPS.

West Hartford, a beautiful suburb of Hartford, Ct., serves as the location for the residences of the business men of the city; there being very little commercialism and no manufacturing in this immediate vicinity.

While its streets are of generous width, they are for the most part lined with large shade trees, so that in the consideration of a proper system for lighting the streets it was deemed advisable to place the source of illumination as much below the foliage as practicable. For this reason it was decided to use a system of small units, placing them well under the foliage and somewhat closer together than usual.

The choice lay between the single-burner gas lamp and the single-glower Nernst lamp; the final decision being in favor of the electric system as having a higher practical efficiency and lower running cost.

The Hartford Electric Light Company is now supplying the Nernst single-glower units to the borough of West Hartford for $18 per lamp-year on an all-night schedule of 3,750 hours, whereas the sixty-candle-power gas unit would not be furnished under $27 per year, using artificial gas at $1 per thousand cubic feet.

The sixty-cycle current, supplied both for the house and street lighting of West Hartford, is generated at the main power plant of the Hartford Electric Light Company, at Tarriffville, fourteen miles away. From there it is transmitted at a pressure of 11,000 volts, three-phase, to the substation in Hartford. Here it is stepped down to 2,400 volts, single-phase, and is carried over two-wire mains to West Hartford, four miles distant. Then the current is again lowered to 230-115 volts pressure for the Nernst and incandescent lamps respectively.

One of the outside wires supplying the Nernst lamp is led through a time switch which may be set to throw the lamps on or off at any desired time.

The primaries of the transformers are fed through single-pole high-tension fuses; lightning arresters being used on the mains only at the Hartford substation.

With the exception of one six-glower unit located in the centre of the district, the installation at present consists of 224 one-glower lamps. These are grouped on thirteen separate circuits, the number of lamps on each varying from ten to

twenty-eight, and each circuit being supplied from a five-kilowatt transformer, centrally located.

The lamps are mounted as shown in Figs. 1 and 2 at an elevation of about twenty feet on standard goose-neck brackets, such as are used in series incandescent systems.

Fig. 1 shows the mounting of the high-tension fuses, transformers and automatic time switch; the latter being placed on the pole within easy reach from the ground. The lamps are placed on alternate poles with a regular spacing of 200 feet.

While the lamps were originally equipped with clear globes, these are gradually being replaced as they become broken with opalescent globes, as the latter seem to give the best results.

The system is regularly patrolled each day before 8 A. M. and after 4.30 P. M. by three boys mounted on bicycles. Each boy carries in a suitable case a number of repaired holders with which he replaces any burnt-out holders he may discover. The latter are returned to the maintenance department for repairs.

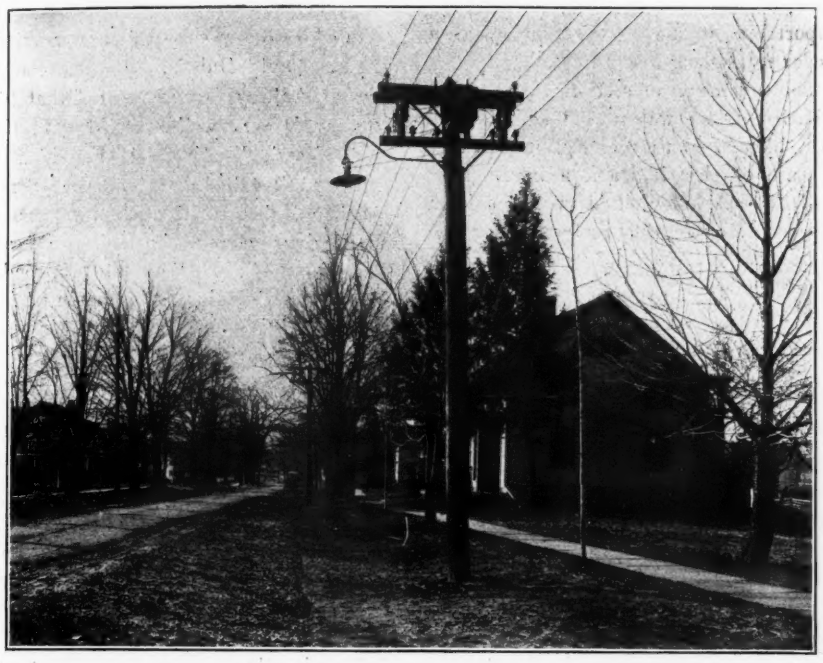


FIG. 1.—NERNST LAMPS FOR STREET LIGHTING IN WEST HARTFORD, CT.

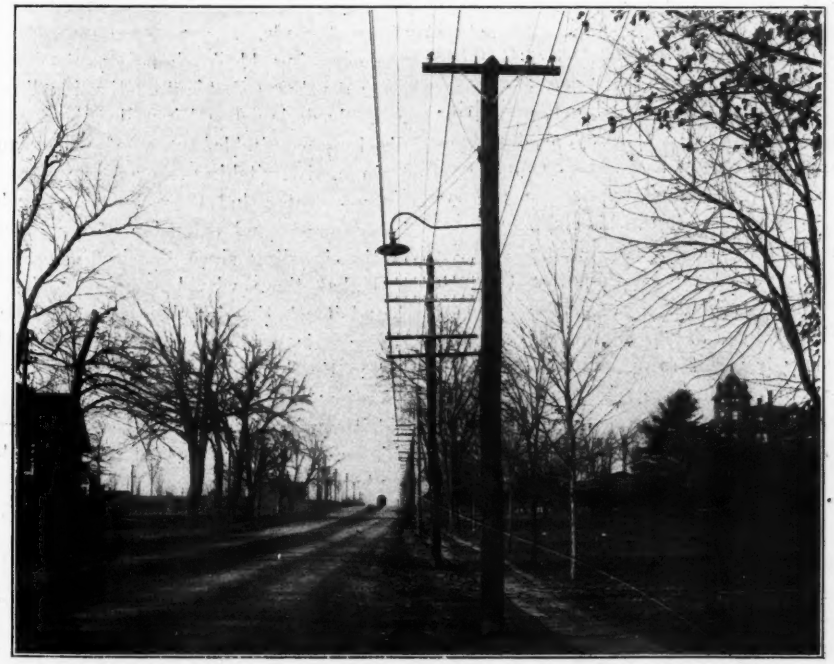


FIG. 2.—NERNST LAMPS FOR STREET LIGHTING IN WEST HARTFORD, CT.

In addition to this repair work, all the inspection and repairing necessary in connection with the Nernst installations in the city of Hartford, amounting to a total of about 2,500 glowers, is done by one man located at the lighting station.

The records kept by the company indicate that the total average cost for maintenance of the commercial and street lighting system amounted to $1.26 per glower for the first six months of the past year. This represents the most recent information available.

The regulation is said to be within five per cent, that is, two and one-half per cent either side of normal, and the life of the glowers is found to be slightly in excess of 800 hours on an average. The company has been asked to install eighteen additional street units shortly.

Two villages Unionville and Farmington, distant thirteen and nine miles respectively from the city of Hartford, both have Nernst street lighting systems similar to that in West Hartford, and are supplied with current from the power plant located at Unionville.

Although not over 200 horse-power in capacity, this plant is strictly up to date in its design and equipment. The normal lighting load of eighty horse-power is supplied from a seventy-five-kilowatt three-phase generator driven by a water turbine. An extra steam-generating unit with sufficient capacity to carry the normal load of the station is held in reserve. The three-phase, sixty-cycle current is transmitted at 2,300 volts pressure from the station to the step-down transformers in both villages, over three No. 4 main conductors; and the transformers which are mostly of ten-kilowatt capacity are connected to these mains through G. E. high-tension cutouts and Wurts lightning arresters. The line has also the usual lightning protection at the station. Both the Nernst street lights and the commercial Nernst and incandescent lighting are supplied from these transformers through three-wire, 112-224-volt secondaries of No. 8 gauge.

The system with a total of 188 single-glower lamps is divided up into six circuits of approximately twenty-eight lamps each; of the total seventy-seven lamps are used for street lighting in Unionville, eighty-six for street service and twenty-five for commercial service in Farmington.

The street lamps are mounted similar to those in West Hartford on standard goose-neck brackets at an average elevation of about twenty feet with a spacing of from 125 to 375 feet between lamps, depending upon the location.

All the lamps are inspected and the necessary renewals made by a boy once every two days. The glowers are allowed to burn out their natural life and the complete records show an average life of 803 hours with a total cost of maintenance per lamp-year, including labor, interest and depreciation, of $2.80; or 8.5 mills per kilowatt-hour.

The International Railway Congress.

Washington, D. C., May 3 to 13—Closing Sessions.

WITH the general meeting at the New Willard Hotel on the afternoon of May 13, the International Railway Congress concluded its formal sessions. On Saturday evening the members of the permanent commission of the congress entertained the American Railway Guild at dinner at the New Willard. On Sunday evening the delegates departed on several tours which had been arranged for them under the direction of the American Railway Association. The next congress will be held in 1910 at Berne, Switzerland.

After the general meeting on Saturday afternoon, a meeting of the permanent commission was held, and all of the old officers were reelected, as follows:

President: A. Dubois, ingenieur, honorary administrateur of the state railways of Belgium, president de la Societe Nationale Belge des Chemins de fer Vicinaux, president de la Societe des Chemins de fer et Minieres Prince-Henri.

Vice-presidents: Alfred Picard, of France; Ramaeckers, of Belgium.

Secretary general: Louis Weissenbruch, engineer in chief of the state railways of Belgium, directeur aux Chemins de fer de l'Etat Belge.

Secretary-treasurer: Edouard Holemans, chief of the division of railways of Belgium aux Chemins de fer de l'Etat Belge.

The following new members were elected: Mr. Paul Morton, Secretary of the Navy; Mr. George E. Stevens, of the Chesapeake & Ohio Railroad; Mr. Charles M. Hay, of the Grand Trunk line; Mr. Frank Barr, of the Boston & Maine Railroad; M. Kologrivoff, of Russia; M. Petri and M. Sarre, of the German government.

The topics discussed by the congress during the closing sessions covered every division of both light and heavy railroading. The application of electricity in various branches of the work excited considerable attention. The most important probably was the discussion taken up under question 8, on "Electric Traction." In addition to this, however, the subjects of "The Lighting, Heating and Ventilation of Trains" and "Automatic Block Signals" were discussed by section 3.

Section 5, in discussing light railways and in considering the question of traffic conveyed by automobiles, recognized the importance of the electric railway as a feeder to existing trunk lines.

The conclusion of section 3 concerning suburban traffic was that it had listened with interest to the description given of the use of electric traction in England and France, but that it was not in a position to express its preference for one or the other method of traction—steam or electricity.

Mr. C. B. Dudley, reporter for America for section 3, on the subject of "The Lighting, Heating and Ventilation of Trains," concluded that the use of candles was being abandoned, except in cases of emergency, and that the same is largely true of oil lamps. The carbureter system seems to have given good results on branch lines. The use of oil gas is being largely extended, while that of coal gas is disappearing. Electric lighting has been tried on a large scale, in five distinct forms: first, by the use of movable storage batteries; second, by the use of storage batteries placed permanently under the cars and charged during stops of the latter; third, by the use of dynamos operated by the motion of the car axle; fourth, by the use of a dynamo placed in a baggage car; fifth, by means of a steam turbine driving a dynamo placed on the locomotive. This last system has been tested only in a few cases.

M. L. Rouet de Journal, of the Madrid-Saragossa-Alicante Railway, Spain, gave complete data on the Vicarino system of electric lighting, as applied to twenty-three cars belonging to his company. The net cost of this system would be 1.55 francs per 1,000 candle-power (French measure) per hour, forty per cent of this being charged to depreciation and interest, twenty per cent to operation, fifteen per cent to maintenance of dynamos, eleven per cent to maintenance of accumulators, seven per cent to keeping up of belts, and seven per cent to maintenance of lamps.

M. Karl Steinbiss, of the royal management of the Altona Railway, Prussia, described experiments in electric lighting undertaken for his railway. The first experiment, undertaken three years ago, consisted in driving a dynamo by a De Laval turbine mounted on the locomotive. The lighting worked well, but the consumption of steam was excessive. This system was abandoned, and a dynamo mounted on the wheels of a car was tried. M. F. Paul Dubois, of the Paris-Orleans Railway, France, stated that his company is very well satisfied with the Stone electric lighting system, which is at present installed in fifty cars. Some suburban trains are lighted by means of a single dynamo set up in the baggage car.

M. C. Boell, of the state railroads, France, reported that, after having tried electric lighting, without great success, by moving accumulators, his management has adopted for the principal trains the Vicarino system, which gives excellent results.

Mr. Anderson, of the government railroads of India, said that lighting by electricity has been considered as a great improvement in Europe and America, and it is almost a necessity in the Oriental countries, because it absolutely avoids heat, and, still better, permits the use of fans by the same current. On the main lines of India about ninety-five per cent of the cars are lighted by electricity, and it is certain that the use of gas will completely disappear.

The conclusion of the congress regarding electric lighting is that systems of electric lighting are giving satisfaction on different roads.

Concerning block signaling, the congress concludes that automatic signaling, properly designed and installed, be recognized as a suitable means of protecting train and switching movements. The congress notes that there has been much improvement and extension of the automatic signaling since the last congress, and that those who have used it have found it effective for their purpose. The congress is not prepared to recommend automatic block signaling for general adoption to supersede existing systems, but it considers that there are cases where this system may present special advantages.

Section 5 concludes, with reference to the influence of light railways on the main lines, that these light railways merit, in the highest degree, the attention of public authorities.

Mr. W. D. Young, reporter for America, on question 8 of section 3, described the General Electric Company's experiments with the single-phase compensated motor at Schenectady, N. Y. Mr. Young's conclusion is that progress

in heavy electric traction requires greater attention to economy of distribution. This means higher voltages, elimination of distribution to substations, and perfecting the alternating-current motor. The present year will be memorable as the inauguration of practical operation with single-phase electric traction in the United States. In January the Indianapolis & Cincinnati single-phase line was opened, and forty miles of track are now finished. The trolley pressure is 3,300 volts, and the transmission line pressure, 33,000 volts, twenty-five cycles. This line, which was installed by the Westinghouse Companies, was described in the ELECTRICAL REVIEW for February 18. In February the Bloomington, Pontiac & Joliet single-phase electric railway was placed in operation. The trolley pressure is 3,300 volts.

The first road in Europe to be operated with single-phase commutating motors is the Stubai Valley road, running into the mountains from Innsbruck, Switzerland. The line is twelve miles long, and for half its length the average grade is more than 200 feet to the mile. The cars are equipped with Winter-Eichberg motors, four motors of forty-horse-power each on each car. The transmission is at 10,000 volts, the current being delivered to the motors at 250 volts, forty-two cycles. Between Murnau and Oberammergau, Switzerland, a single-phase electric line was opened early in the year. Current is generated at 5,000 volts, sixteen cycles, and fed directly into the line at this pressure. The motors are of the single-phase commutator type, made by the Siemens-Schuckert Company.

The objection to the three-phase system is shown to be the use of three conductors, with the resulting complications. It appears to be adapted to long lines where the traffic requires few stops. It is also well suited to mountain railways where the current is returned to the line while running down grade, when the motors act as generators.

In connection with the single-phase motor, the problem of collecting the current requires careful study. On account of the high voltage it is necessary to place the conductors out of reach, and the overhead wire should be used. The third rail, which has caused so much discussion, and which results in complications at crossings and terminals, will doubtless be abandoned in favor of the overhead conductor where the single-phase motor is used.

Mr. Ernest Gerard reported for Great Britain and Belgium. The conclusion that Mr. Gerard reaches is that, in England, electrification is attended with an increase in the number of trains and in the facilities offered to passengers. This is followed by an immediate increase in the number of passengers and in the receipts, with a material decrease in the cost per train-mile, an increase in speed, and a considerable improvement in comfort.

M. Victor Tremontani, in his report for all other countries, concludes that electric traction offers many advantages and few objectionable features. From his observation, he concludes that the technical and financial advantages resulting from the application of electric traction to steam roads are worthy of the attention of the managements, and a large number of steam lines would profit by being electrified.

During the discussion on electric traction, Dr. Friedrich Schulz, head of the German delegation to the congress, presented an interesting paper on the Berlin-Zossen high-speed experiments. He also exhibited many photographs of the track equipment and electric conductors. Dr. Schulz was chairman of the investigating committee for high speeds which built the Zossen railway.

Mr. J. F. Aspinall, of the Lancashire & Yorkshire Railway, England, stated that the results have shown that, with electric traction, the cost per ton-mile is greater, and for the train crews, less. Electrification of the line cost about $100,000 per mile, or about three and one-half times the cost of steam equipment. Electric traction makes possible a volume of passenger business that can not be handled at terminals by steam locomotives, and it thus becomes profitable, in spite of its apparently increased cost when measured on the ordinary basis.

Throughout the stay of the delegates to the congress at Washington they were most hospitably entertained by the officers of the American section. Mr. and Mrs. Stuyvesant Fish held a number of formal receptions. The reception tendered by Mr. George Westinghouse on the evening of Wednesday, May 10, was one of the most brilliant of the season, and was attended by nearly all the delegates and a large proportion of Washington society. Visits were made to all of the historical points in and about Washington, and on the afternoon of the last day of the session the Honorable Theodore Roosevelt, President of the United States, received all the members of the congress and others at a garden party in the White House grounds.

The American Railway Appliance Exhibition, which closed its doors on the evening of May 13, was brilliantly successful. That this success was possible is largely due to the principal officers in the management of the exhibition—Mr. George A. Post, chairman; Mr. J. Alexander Brown, director, and Mr. Charles A. Moore, treasurer. The exhibits were unique in their characteristics, devoid of decoration and spectacular features, designed to show to experienced and expert railroad men the detailed construction and practical operation of every device. The various exhibits were frequently visited and carefully studied, especially by the foreign railroad officials, who expressed astonishment and gratification at the wonderful accomplishments of American manufacturers. Success must be the final word in any account of the International Railway Congress and the American Railway Appliance Exhibition. While many prominent officials of the two organizations are entitled to much credit for these results, the satisfactory outcome is really due to the spirit of concord, the friendly cooperation and the intelligent enterprise of every man connected with the congress and exhibition. Among the American officials of the congress, Mr. Stuyvesant Fish is entitled to particular credit, and Secretary W. F. Allen, of the American section, was constantly at his post keeping everything running smoothly.

On Sunday the members of the congress departed from Washington on the various tours. Two general tours were established—one designated as the long tour, and the other as the short tour. The long tour brings the delegates to Altoona, Pa.; Pittsburg, Pa.; Cincinnati, Ohio; St. Louis, Mo.; Chicago, Ill.; Buffalo, N. Y.; Niagara Falls, N. Y.; Montreal, Canada; Schenectady, N. Y., and Saratoga, N. Y. This tour occupies the time from Sunday, May 14, to Saturday, May 27, the total length of the trip being about 2,700 miles.

The short tour brings the delegates to Altoona, Pa.; Cleveland, Ohio; Buffalo, N. Y.; Niagara Falls, N. Y.; Schenectady, N. Y., and Boston, Mass. This tour occupies the time from Sunday, May 14, to Tuesday, May 23. The total length of the trip was about 1,500 miles.

At Schenectady the delegates will be entertained by the officers of the General Electric Company. The great works of this company will be visited, and the new electric locomotives being built for the New York Central & Hudson River Railroad Company will be offered for inspection and demonstration.

At Pittsburg, Pa., the delegates are the guests of the Westinghouse Electric and Manufacturing Company. A large part of the time spent in Pittsburg is to be occupied in going through the extensive works of this company.

At Cincinnati, Ohio, a number of the party journeyed to the Norwood works of the Bullock Electric Manufacturing Company, where they were entertained after an inspection of the shops.

PROGRESS IN THE DEVELOPMENT OF THE ELECTRIC DRIVE.[1]

BY SIDNEY B. PAINE.

In April, 1895, a paper was presented before the New England Cotton Manufacturers' Association on "The Electrical Driving of Textile Establishments." In that article a general description was given of the system and methods which had been adopted in the first textile mill in this or any other country, to be driven electrically throughout. At that time, the first mill had been running about nine months. Much progress has been made during these ten years. The writer has a record in detail of 128 different textile corporations which are using about 90,000 horse-power of electric motors. It is a conservative estimate that approximately 175 textile mills in this country are using electrically about 140,000 horse-power. The census of 1900 showed that 1,165,048 horse-power was used by the cotton, woolen, worsted and silk mills in the United States. Assuming an increase in the last five years of twenty-five per cent we find that about ten per cent of all the power used in these industries is obtained from motors. When we consider the fact that, at the outset, the electric system was as new to engineers as to the manufacturers, we can understand why the progress has not been even more marked. It may be of interest to analyze the above 90,000 horse-power of which the above record has been kept in detail. Fifty-four thousand horse-power is generated by steam, 33,000 horse-power by water power and about 3,000 horse-power by water and steam combined. Forty-two new mills have been built in which the electric drive was adopted at the outset. In twenty-eight of these forty-two mills, the energy is generated by steam and in fourteen by water power. Most significant, however, is the large number of mills which are operated from central power stations. Twenty-two mills are thus driven entirely by current generated by an outside and independent corporation, while twenty-two mills purchase 5,586 horse-power to supplement the power generated upon the premises. This indicates very clearly the tendency toward "centralization of power," which the writer has advocated for several years. This movement has not been confined to this country, for in England two large power companies have been organized, in Yorkshire and Lancashire respectively, which are soliciting business from the textile mills. Two years ago a prominent English manufacturer remarked to the writer, "we have been watching your progress in America, and believe that your experimental work is nearly completed. We are about ready to adopt your system." The signs are not lacking that they are on the eve of a forward movement in this direction.

In all its essentials, the system followed to-day is the same as that adopted ten years ago. In some few details, improvements have been made. The principal change has been in the direct connection of the motor to the spinning-room shaft. In the first mills this arrangement was adopted for the picker room only. There has been a marked advance, however, in the recording and indicating instruments. At first we had to depend upon the ammeter and voltmeter. The use of these instruments was found to be unsatisfactory, as the readings of the ammeter had to be corrected by the readings of the voltmeter, and did not even then give a correct indication of the amount of energy furnished by the motor. The use of the indicating wattmeter corrected this difficulty, but no continuous record could be kept by that instrument. Then followed the curve-drawing wattmeter, by which the record was drawn by a pen on a revolving disc. This was open to the objection that its record, especially on light loads, was too short to be of much service. The latest instrument to be developed is the registering wattmeter, by which the record is drawn upon a strip about three inches wide, at the rate of three or six inches per hour, as may be desired. The duration of this record depends upon the length of the strip.

A test was made in a fine goods mill and continuous record curves were obtained. The speed on each strip was such that three inches passed under the pen in one hour. Fifty such continuous curves were taken in this mill, each representing the record of half a day. In addition, five special tests of shorter duration were made. A recording wattmeter was also connected in the circuit to record the total energy, and an indicating wattmeter was used to give instantaneous readings at ten-minute intervals and to check the registering wattmeter. Careful record was made of temperature outside and also inside the mill and of the humidity both relative and actual. Memorandum was made of all particulars connected with the machinery driven. Great difficulty was experienced in determining the actual number of machines in operation at a given moment, but especial care was used to have the record as accurate as possible. The curves are the record of a run for a Saturday morning and the first five days of the following week, of a 200-horse-power motor in a ring spinning room, and indicate the current delivered to that motor during the period. The writer knows of no method which can determine accurately the friction losses of a system, either mechanical or electrical, under working conditions. The friction load tests do have a comparative value, however, for they detect any change or undue losses from day to day. No importance has been attached to the tests of portions of machinery to determine the power required for a single frame or number of frames. Such a test depends for its value upon the assumption that all the machines of the same description consume the same amount of power. This is manifestly an incorrect hypothesis, especially on spinning frames. What we are all interested in, is the amount of power required to run a room or a section containing a given number of spindles, together with the necessary shafting and belting.

The 200-horse-power motor under test operated fifty-two frames, aggregating 11,648 spindles. The spindle speed was supposed to be 9,000 revolutions per minute, but at that time we had no instruments suitable for determining the accuracy of this assumption. The gauge was two and three-fourths inches, diameter of the ring one and one-half inches, and the traverse six inches. During this test one frame spun No. 40 yarn; seven frames spun No. 50 yarn; nine frames spun No. 60 yarn; eight frames spun No. 65 yarn; eighteen frames spun No. 70 yarn; five frames spun No. 80 yarn; four frames spun No. 100 yarn.

The following facts may be deduced from the results obtained on the five days of the following week:

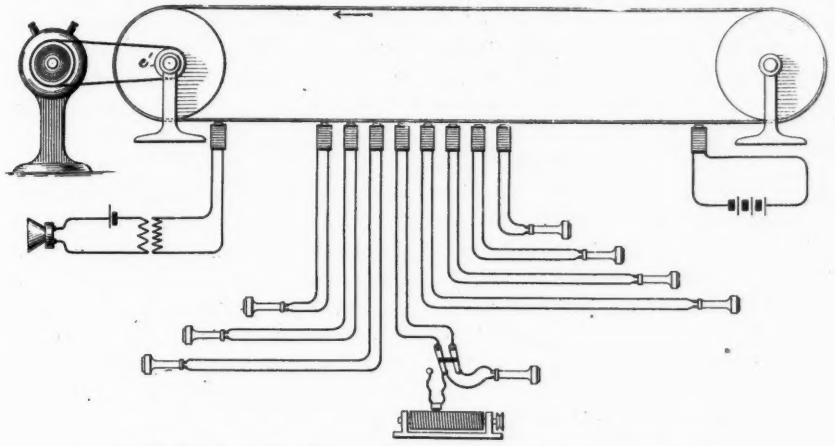
	Percentage of Machinery in Operation.		Spindles per Horse-Power.	
	A. M.	P. M.	A. M.	P. M.
Monday.....	93.6	94.6	69.41	75.97
Tuesday.....	93.9	98.4	71.97	76.67
Wednesday.....	95.1	97.1	72 64	74.37
Thursday..	9402	94.6	71.04	74.21
Friday	96.3	96.7	72.32	74.03
Aver. for 5 days...	94.6	96.3	71.48	74.61
Total average.....	95.4		72 95	

The results obtained in these tests illustrate the difficulty, to say the least, which would be experienced in an attempt to obtain similar information by means of indicator cards taken at the engine cylinder. The power required to operate machinery varies from day to day and even between forenoon and afternoon of the same day. If all the frames were in operation at the time of the test, the result would be misleading, as it would be more favorable than if normal conditions had prevailed. The advocates of the electric system believe that by its use much valuable information may be obtained and that thereby the manufacturer can keep himself informed as to what is transpiring within his mill.

[1] Abstract of paper presented at the annual meeting of the New England Cotton Manufacturers' Association, April 26-27, 1905.

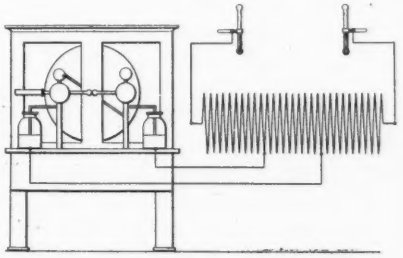
Electrical Patents.

Valdemar Poulsen, of Copenhagen, Denmark, has patented in the United States an apparatus for electromagnetically receiving, recording, reproducing, and distributing articulate speech, etc. (788,728, May 2, 1905). The present invention utilizes the principle disclosed in a previous patent granted to Mr. Poulsen, on November 13, 1900, and numbered 661,619. In the patent referred to, a method is described of recording electrical impulses which are created by sounds or other means in an electrical circuit, which consists in tracing a magnetic record thereof in a steel body by means of an electromagnet, through which the said impulses flow. The steel body retains the magnetic record or impression, and when it is desired to reproduce the speech or signal the magnet is subjected to the magnetic impressions, and electrical impulses of the same character are again created in the circuit containing the magnet. If the original impulses be created by the voice acting upon a telephone transmitter, the reproduced impulses may be caused to affect a telephone receiver which will then give out the same message that was spoken into the transmitter. As above stated, the present invention utilizes this principle, but consists of a means whereby the recorded message is substantially simultaneously reproduced and distributed to an indefinite number of receiving instruments immediately after it has been recorded, thereby rendering it possible for a number of persons or instruments to receive the same message at a number of different points. The apparatus therefore becomes useful as a means for distributing information or news of any character to an indefinite number of subscribers simultaneously.



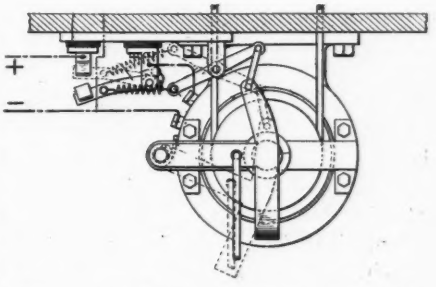
Speech-Recording, Reproducing and Distributing Apparatus.

An electrotherapeutic apparatus is the invention of Charles F. Marsh, of Pensacola, Fla. (789,040, May 2, 1905). The object of the invention is to provide a device of a simple and effective nature for producing a current of such high frequency and potentiality and such low amperage that it is extremely valuable for therapeutic purposes, the current being rich in penetrative force. Another object is to provide the apparatus with electrodes of novel construction whereby an increased quantity of ultra-violet rays is produced, together with a ray more potent than the ultra-violet and less injurious to tissues than the X-ray, this new ray being between the ultra-violet and the X-rays. In carrying out the invention a resonator is provided. A source of alternating current is connected with the coils of the resonator at points equidistant from each other and from the ends of the coils. Vacuum electrodes are provided, containing a resistance material, and electrical connections are located between the resistance material in the electrodes and the respective terminals of the coil. An electrode is employed comprising a handle, a yoke thereon, and a strap hinged to the yoke. A vitreous vacuum tube is enclosed by the yoke and the strap. Carbon is placed in the tube, and a circuit is established from the yoke to the carbon by a conductor provided for that purpose.



Electrotherapeutic Apparatus.

Herbert B. Coho, of Mount Vernon, N. Y., has assigned by mesne assignments a one-half interest in a patent obtained by him on switch and connection controlling electric motors and power transmitters to Wheeler & Wilson Manufacturing Company, of Connecticut, and the Emerson Electric Manufacturing Company, of St. Louis, Mo. (788,518, May 2, 1905). The invention relates to an improved switch or cutout and its connections with an electric motor and power transmitter, and has for its object to provide simple, compact, and efficient mechanism of this character so arranged that the switch may be very quickly adjusted to cut the motor into and out of circuit to avoid injury to the switch-contacts, and so that after cutting in the motor it will start and attain full speed before the power transmitter is adjusted by the switch-controlling means for operating a machine to be driven. The invention is more especially adapted for use in operating a sewing machine, but it may be used in whole or in part for other electric power transmitting purposes. In the embodiment of the invention, the connections comprise two binding-posts, one serving as a contact, the other having a switch-lever fulcrumed to it, which lever carries a contact adapted to the first-named contact. An operating lever is employed to which is connected one or more springs, these springs being also connected to the switch-lever and quickly opening and closing the switch as the switch-lever is adjusted by the operating lever. An electric motor is provided. A power transmitter including a wheel is loose on the motor shaft, the loose power transmitter wheel being engaged by a controlling lever with the motor-driving wheel. Means are also provided for coupling the controlling lever with the switch-operating lever.



Switch and Connections Controlling Electric Motors and Power Transmitters.

Electrical Project in India.

The Kashmir project in the state of Mysore, India, has been sanctioned, and plans are being made to carry out this great scheme. The proposition includes a 17,000-horse-power hydroelectric installation, to supply power for a 200-mile electric railway, a large electric dredging outfit, besides light and power for other purposes. It is not improbable that the single-phase, alternating-current system will be used on this road.

Reviews of Current Engineering and Scientific Literature.

Electrical Repairs at Sea.

According to the author of this communication, the electrical expert on the man-of-war is greatly hampered by a lack of adequate testing apparatus, and he is often forced to devise crude expedients for conducting the required tests. For instance, on a British man-of-war a large number of Leclanche cells are used for gun circuits, bells, telephones and all manner of open-circuit work. It is necessary to test these continually to see that they are in good working order. The test that is laid down is based upon the capability of each cell to fuse a certain length of platinum-silver wire, equal to that of an ordinary gun fuse, through a specified resistance. It is practically impossible to test all of the cells in this way. The writer gets over the difficulty by selecting one cell which gives the required current. He then, by means of a so-called detector—which is simply a crude galvanometer—adjusts the circuit to obtain a given deflection when this cell is in circuit. By replacing the cell consecutively by all those to be tested, the ones which give the required current are easily picked out. On shipboard no potentiometer is supplied, but a convenient little instrument is constructed by splitting a good drawing pencil in two, which may be done by soaking in water until the glue is soft. That half of the pencil which contains the graphite core is used as the potentiometer. The graphite core must, of course, not be broken. Connections are made at the two ends simply by twisting copper wire around the wood and graphite, being sure that good contact is made. The sliding bridge consists of a loop of copper wire also twisted around the wood and graphite, but loose enough to be slipped along. A scale is laid off upon the wood, and the detector mentioned above serves as the galvanometer. By means of this little device tests have been carried out satisfactorily even in out-of-the-way corners. Another crude form of potentiometer is obtained by connecting the searchlight resistance in series across the supply circuits, as each of these has a definite resistance so that the fall of potential between any two points can be estimated. This arrangement has been used to check the ammeters and voltmeters which are used throughout the vessel.—*Abstracted from the Electrical Review (London), April* 28.

Some Notes on the Efficiency of Steam Plant.

A comparison is here made by Mr. Walter A. Vignoles between the fuel economy of electric generating plants and marine engines. The figures are taken from English practice only. The lowest coal consumption recorded was at the Glasgow tramway power station, where the figure was 3.64 pounds per kilowatt-hour. The highest figure was for black coal, where it was 15.4 pounds per kilowatt-hour. The best results for the marine engine were obtained during the trial of the first-class cruiser Monmouth, when developing 16,326 indicated horse-power. The coal consumption per indicated horse-power-hour was 1.45 pounds. The poorest results were given by the sloop Clio, when developing 311 indicated horse-power. The coal consumption was then 2.32 pounds per indicated horse-power-hour. If an efficiency of eighty-five per cent from the engine to the switchboard is assumed, for the first figure the coal equivalent per kilowatt-hour would be 2.28 pounds. Assuming an efficiency of eighty per cent, for the performance of the sloop Clio the equivalent coal per kilowatt-hour would be 3.88 pounds. The author endeavors to determine why marine practice gives better results than stationary practice, and he concludes that the load-factor has only a small effect upon the pounds of water evaporated per pound of fuel burned; that the steam consumption in a central station equipped wth a number of sets, compared with the total load on the dynamos, may be shown by an approximately straight line—in fact, the "Willans law" for a steam engine is applicable to a central station; that the average steam consumption during any period may be determined by working out the average load, when the consumption can be read from the curve; and that the load-factor does not give sufficient information about the conditions of the load, but that the capacity of the station should be substituted for the maximum load observed in working out the load-factor. The large consumption of coal in many central stations may be due to the small plant load-factor resulting from excessive steam consumption. Too much attention can not be paid to economizing steam at light loads, and, to do this, greater attention must be paid to the economy of auxiliaries, not only at full load, but at light load. All steam pipes should be kept as short and as small as possible. It is probable that in plants of considerable dimensions the unit system now being adopted will be the best, keeping each unit as compact as possible, and reducing steam pipes and connections to a minimum.—*Abstracted from the Electrician (London), April* 28.

The Test of a 5,000-Kilowatt Alternator.

The method adopted for testing the 5,000-kilowatt alternators installed in the Seventy-fourth street power station of the Interborough Rapid Transit Company, New York city, is here described by Mr. L. L. Gaillard. Each machine is rated at 5,000 kilowatts, 11,000 volts, twenty-five cycles, at 700 revolutions per minute. They were built by the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., and each is direct-connected to a double horizontal-vertical Allis-compound engine. It being impracticable to measure the iron losses in the usual manner, test rings were made up of samples of the material used for constructing the armature. The losses were determined for these rings. The total iron loss was found to be 38,693 watts. The resistance of the armature is 0.3493 ohm; the resistance of the field, 0.8206 ohm. From these figures the efficiency of the machine has been computed for different loads. They are as follows: one-quarter load, 94.29 per cent; one-half load, 96.50 per cent; three-quarters load, 97.71 per cent; full load, 98.06 per cent; one and one-quarter load, 98.24 per cent. The no-load saturation curve was obtained in the usual manner, simultaneous readings being taken of the field current and armature voltage at constant speed. The short-circuit characteristic was obtained by short-circuiting the armature and running the machine at full speed, the armature and field currents being noted. This characteristic is a straight line passing through the origin and a point corresponding to 750 amperes in the armature and 180 amperes in the field. The insulation tests were made by using a 250-kilowatt, 40,000-volt transformer. The regulation of the machine was calculated, and was found to be 4.5 per cent. This is probably too small, but it was not convenient to check it by an actual test. Temperature measurements

gave the following results after a run of seventeen hours with an average load of 5,000 kilowatts: the temperature rise above the air for the field winding was 22.5 degrees centigrade; for the armature winding, 22.6 degrees centigrade, and for the armature laminations, 25.5 degrees centigrade.—*Abstracted from the Electric Club Journal (Pittsburg), May.*

A New Dynamo for Train Lighting.

An interesting method of lighting trains is described here by Dr. A. Rosenberg. The author first explains the H. Rosenberg system, from which the new one has been developed. The original system consisted of a small dynamo driven from the car axle. Upon the same shaft was a small auxiliary dynamo, which served to excite the former. This machine was itself excited from the storage batteries on the car. The peculiarity of this system is that, when the direction of motion of the car is reversed, the direction of rotation of the exciting dynamo is reversed, although its excitation is not changed. This reverses the excitation of the main dynamo, and hence maintains its polarity unchanged. To obtain regulation, a second or series winding was placed upon the auxiliary machine, which winding carried the whole current of the main dynamo, and acted in opposition to the battery excitation. By this means a practically constant current was obtained independent of the speed of the car. This system is inconvenient because of the number of parts, so that the author sought to simplify it by doing away with the exciting dynamo. In explaining it, a two-pole machine is assumed, which has a constant excitation due to the battery. The armature of this machine has two windings, one of them having a fairly high resistance. The brushes for this winding are placed midway between the poles in the usual position, and are short-circuited. This is the exciting winding. The brushes for the working winding are placed at an angle of ninety degrees to the others, and hence come midway under the poles. As the machine is revolved, the magnetic field due to the battery excitation sets up electromotive forces in both windings. Due to the positions of the brushes, there is no difference of potential between those which deliver the working current, but a current will flow through the exciting winding. This winding is arranged so as to set up a strong armature reaction, and, due to the position of the brushes, this distorts the magnetic field set up by the field winding. According as the machine revolves right-handedly or left-handedly, this distortion will be to the right or the left, and, due to it, a difference of potential will be produced between the brushes of the working winding. Due also to the fact that this effect is reversed with a reversal of the direction of rotation, the polarity of the working brushes is not changed. The machine thus automatically takes care of change in the direction of motion of the car, and is self-exciting. The characteristics of this machine are peculiar. As the speed increases, the current delivered rises rapidly, but soon becomes nearly constant. Results were shown for a particular machine, in which the current becomes practically constant at about 1,000 revolutions, and changes very little from here up to 2,400 revolutions. By changing the current through the field winding, this characteristic can be shifted, and the machine be made to deliver a constant current whose value may be anything between ten and fifty amperes. The system, in other details, differs but little from previous systems. The dynamo is suspended from the car trucks and is driven by a belt. The voltage at the lamps, however, is controlled by means of fine iron wire resistances enclosed within coils similar to the ballast coils of the Nernst lamp.—*Translated and abstracted from Zeitschrift für Elektrotechnik (Vienna), April* 30.

The Use of Caustic Alkalies in the Nickel-Iron Accumulator.

Some instructive suggestions regarding the use of caustic alkalies in accumulators are here given by Dr. M. U. Schoop and M. Charles Liagre. Those liquids having the best conductivity are the most suitable as electrolytes for accumulators. They are acid and alkaline solutions. The salt solutions have a greater resistance. Among the acid solutions, sulphuric acid alone has been employed with success. The others—hydrochloric acid, nitric, etc.—have a lower conductivity, and at the same time they are not as suitable for taking part in reversible reactions. In the lead accumulator the use of sulphuric acid is justified both on account of its conductivity and because the lead sulphate formed on the electrodes is insoluble in the solution. In view of this condition, it is interesting to examine all solutions of sodium and potassium, so as to determine the best conditions for using them. Solutions of potassium hydrate, as is true of sulphuric acid, show a maximum conductivity when containing twenty-nine per cent of potassium hydrate. A fifteen per cent solution of sodium hydrate gives the highest conductivity. Of these three solutions, sulphuric acid is the best conductor. Then comes potassium hydrate, the sodium hydrate being the poorest. Although a solution of potassium hydrate for a given concentration has a greater resistance than a similar solution of sulphuric acid, since the electrodes in the alkaline accumulators are separated by distances much less than those in the lead accumulator, the total resistance of the electrolyte in the cell is less than that of the lead cell. It is this latter resistance that enables the alkaline accumulator to discharge at such high rates. Potassium hydrate forms a better solution for the alkaline accumulator than sodium hydrate because it is a better conductor, and the change in conductivity with temperature is less rapid. During use, the concentration of the electrolyte in the alkaline accumulator varies for different levels, due to the action of gravity and to the different speeds of migration of the potassium and hydroxyl ions. The effect is similar to what takes place in the sulphuric acid solutions. There is a tendency to form potassium ferrate in concentrated solution, which is undesirable, and as a more dilute solution requires less potassium hydrate, a twenty per cent concentration is generally used instead of the twenty-nine per cent, which gives the maximum conductivity. An objection to the alkaline solutions is their caustic nature. They blister and destroy the skin, and form wounds which are difficult to heal and sometimes dangerous. To prevent this a solution of boric acid or citric acid should be kept handy to neutralize the alkali. It is particularly necessary to protect the eyes from the alkaline spray. The clothing should be protected by aprons of canvas. To prevent the formation of carbonates, the electrolyte must be protected from the air, which may be done by coating the surface with a non-saponifying oil, but the gas set free forms a foam and may give rise to explosions. In the laboratory the best and simplest way is to cover the jar with a plate of glass. The density of the solution should be watched carefully so as to keep it at the correct point. An ordinary hydrometer may be used, but for more accurate work a more sensitive instrument has been devised by M. Schoop. It is very important to use pure materials in forming the solution. Commercial alkalies often contain chlorine, and organic matter which is deleterious to the cell; hence it is also essential to add only distilled water to the electrolyte. Because of the dangers and difficulties arising from the use of the caustic alkalies, substitutes for them have been sought. M. T. von Michalowsky suggests the aluminates of the alkali. As in these aluminates the oxide of zinc is insoluble, he recommends a nickel-zinc cell. These electrolytes are not changed by the passage of the current if the two electrodes are insoluble. The action is similar to that supposed to take place in the nickel-iron cell. Unfortunately the conductivity of the aluminates is not so good, and this condemns the cell.—*Translated and abstracted from L'Éclairage Électrique (Paris), April* 29.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

New Fort Wayne Induction Integrating Wattmeters.

The Fort Wayne Electric Works, Fort Wayne, Ind., has developed a new single-phase integrating wattmeter known as the type W. The exterior appearance of this instrument, with glass case, is shown in Fig. 1. The instrument occupies a space eight and one-quarter by seven by four and five-eighths inches, and weighs less than ten pounds complete. The interior construction is simple and compact, but ample space is allowed around all the operating parts. It is so built that it may be easily assembled or dismantled.

All connections with the line are made

FIG. 1.—FORT WAYNE WATTMETER WITH GLASS CASE.

to binding-posts, which are protected from accidental short-circuits. These are located inside a separately sealed terminal box on top of the meter. No shunt-circuit wires need be extended, and no soldered connections need be outside the meter. Both sides of the two-wire circuit, or the outside wires of a three-wire circuit pass through the terminal box.

The register has four dials, and is mounted on slotted projections held by two screws to the dial bracket on the mechanism frame. This assures accurate alignment with the rotating element. No constants are necessary. The smallest reading is in kilowatt-hours.

The upper bearing for the rotating shaft is inverted. The end of the shaft is hollow, and rotates about a stationary, flexible steel needle mounted in the top bearing stud. The flexible feature is designed to eliminate noise and vibration, and the hollow top of the shaft permits lubrication, if desired, without the possibility of oil being drawn to the worm-wheel by capillary attraction. This construction also permits freedom of motion of the upper end of the shaft without liability of permanently bending the upper bearing.

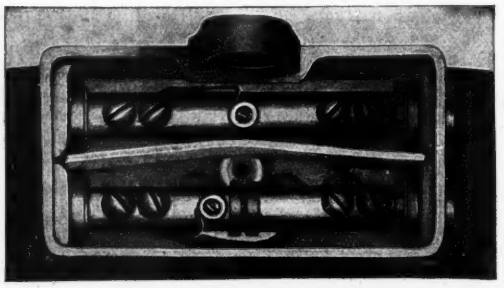


FIG. 2.—INTERIOR OF TERMINAL BOX.

The rotating element of the meter is a small aluminum disc, which is mounted on a short phosphor-bronze shaft, and held in place on the shaft by a set screw. The disc may readily be moved vertically to permit adjustment with the air-gap of the magnet.

The lower end of the phosphor-bronze

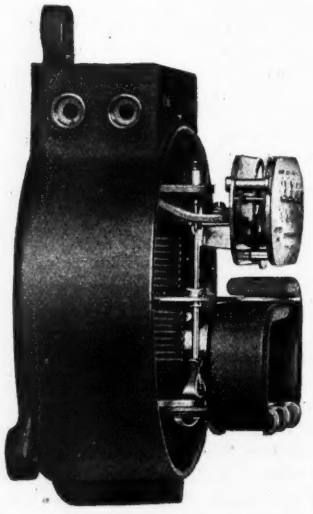


FIG. 3.—SIDE VIEW OF WATTMETER, SHOWING POSITION OF PERMANENT MAGNET.

shaft has set into it a small hardened steel tip with a rounded end. This tip bears on a sapphire jewel, which is elastically supported on a carefully adjusted spring mounted in the jewel screw. The jewel screw is the only movable part of the lower bearing. For relieving the jewel from pressure when not in operation, the jewel screw is partially withdrawn, allowing a spring clamp to close on the shaft and hold it in place until the jewel screw is again tightened. This forces the spring to release the shaft. The clamp acts horizontally, and exerts no strain whatever on either bearing or shaft.

The permanent magnet is in front of the shaft, as shown in Fig. 3. It is attached to the lower bearing bracket by two screws, which engage with slotted lugs on the magnet clamp. It is maintained in position with relation to the centre of the disc by a sliding gauge, which can be locked. After the gauge is set, the magnet may be removed and replaced freely without further adjustment. The gauge is a part of the magnet clamp, and is not changed by the removal

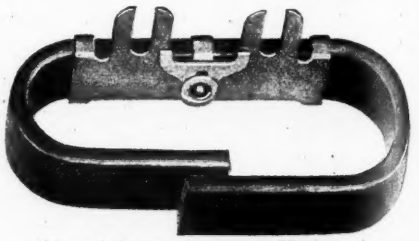


FIG. 4.—GAUGE-ADJUSTED MAGNET OF FORT WAYNE WATTMETER.

of the magnet. The gauge-adjusted magnet is shown in Fig. 4.

The two series coils are fitted with spiders, each attached to the main frame with a single screw, and located opposite the shunt coils in the back of the meter. For three-wire circuits they are double-wound to avoid the effects of unbalanced loads. The shunt coils are mounted on the upper and lower arms of the magnetic circuit.

For sixty-cycle circuits the type W meter has a lagging connection on the outside of the lower shunt coil. The 140-cycle meter has a 140-cycle lagging connection on the upper shunt coil, in addition to the sixty-cycle connection below, and it can be altered for use on the lower frequency. The meters are wound for 110 to 220 volts, and two or three-wire service. They are made in capacities of five, ten, twenty and forty amperes, without transformers.

New Decade Resistance Box.

The Leeds & Northrup Company, Philadelphia, Pa., has recently placed on the market a new line of Wheatstone bridges and resistance boxes of the decade type. In the accompanying illustration is shown

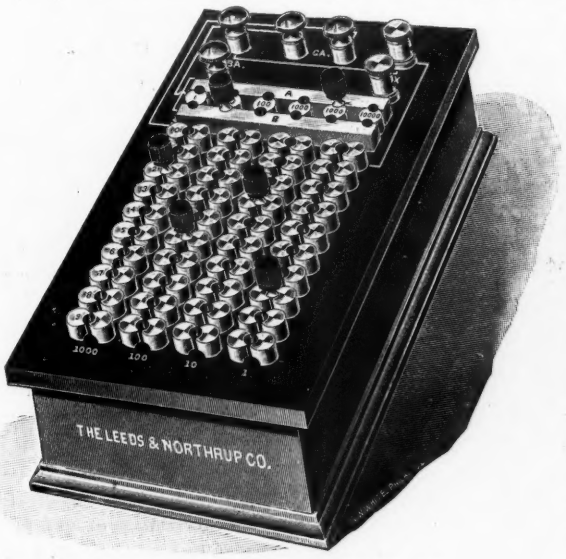


FIG. 1.—NEW DECADE RESISTANCE BOX.

a resistance box with four rows of resistance, ranging from one ohm to 10,000 ohms in the rheostat, and with six resistances in the bridge, all of which may be used in either arm. The advantages claimed for the decade plan of connecting

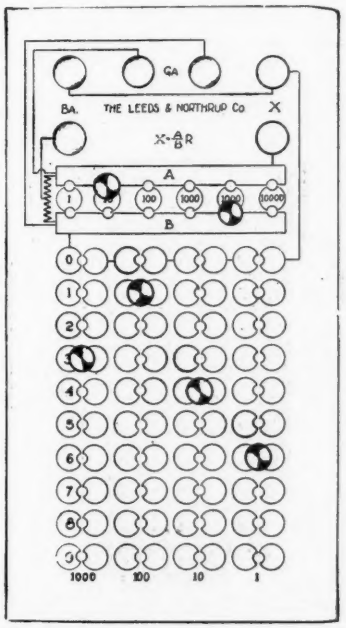


FIG. 2.—ARRANGEMENT OF RESISTANCES, NEW DECADE RESISTANCE BOX.

the coils in the rheostat over the regular post office or other plug-out methods are as follows: each decade requires a single plug, which is never out of use. The plug is either in the zero position or set at some value, and is consequently not easily lost while being laid aside. As each decade requires but one plug, the value can be read from the position of the plug, without the addition of any series of values, as in the other plans of connection. No block in the rheostat has a plug attached to two sides of it. On this account there is no possibility of a good plug fit being disturbed by the removal of a plug from the other side of the block, which is of advantage in ensuring good contacts and accuracy.

In this line of boxes there is a unique arrangement of the bridge-arms, which minimizes errors due to contacts, and facilitates interchanging the arms. Any one of the coils in the bridge may be connected to either bridge-arm. The bridge can consequently be reversed, and the coils interchanged very simply.

The resistances are made of wire which has a low temperature coefficient, and requires no correction at all for accuracies to one-tenth of one per cent for ordinary changes of temperature. The wire has also a negligible thermoelectric force against copper, and consequently no corrections have to be made in using it. An unusual thickness is given to the hard-rubber top for this class of apparatus, in order to prevent the possibility of buckling, and to ensure continued good plug fit.

The "Duplex" Mast-Arm.

The Buffalo Specialty Manufacturing Company, Buffalo, N. Y., is introducing the "Duplex" mast-arm for suspending lamps in street arc lighting. The arm is made of two lengths of one and three-eighths-inch steel tubing, approximately parallel to each other, both ends of which fit into malleable iron sockets, and braced together in the centre by means of an expansion bridge. The bridge allows the pole-ends of the two lengths of tubing to spread in order to adapt the arm to any size of pole. The necessary fittings, including pulley casings, are cast on the iron sockets. The arm is fitted with a pulley casing at each end of the tubing. These are equipped with six-inch pulleys for the cord or cable to pass over. The fittings on the pole-end of the mast-arm have two eyes, which hook over two projecting horns, attached to the pole, one on each side, previous to the erection of the arm. The tops of the projecting horns also serve to hold the glass insulators.

The arm is held in a horizontal position by a substantial supporting rod, which has a suitable adjusting device to adjust the arm in a perfectly horizontal position. One end of the rod is attached to the arm near the lamp, and the other is attached to the pole about four feet below the point where the mast-arm proper is secured to the pole. This distance will vary according to the length of arm used.

The lamp is attached to a cord or cable which passes up over the pulley, thence inside of and completely through the entire length of one of the tubes, and then over the pulley to the pole-end and down the pole. The cord is protected from the weather by passing through the tubes.

A Handsome Railway Congress Souvenir.

A very handsome souvenir catalogue is being distributed at the International Railway Congress, Washington, D. C., by the Westinghouse interests. This catalogue details the development and scope of work of the Westinghouse companies in the railway and industrial fields. The contents contain, in addition to the introduction, descriptive matter concerning the Westinghouse Air Brake Company, the Union Switch and Signal Company, the Westinghouse Electric and Manufacturing Company, the Westinghouse Machine Company, Westinghouse, Church, Kerr & Company, the Cooper Hewitt Electric Company, the Sawyer-Man Electric Company, the R. D. Nuttall Company, Nernst Lamp Company, Pittsburg Meter Company, and Canadian Westinghouse Company, Limited.

In addition to the text there are numerous views of the different works of the Westinghouse interests together with reproductions of the apparatus manufactured by the different companies. The book is replete with interesting information, and shows excellent execution in every page. A fine half-tone engraving of Mr. George Westinghouse is used as a frontispiece, and the work is handsomely illuminated in green and gold on a pebbled paper cover.

The total amount of anthracite coal produced in the United States since 1814, the date of earliest record is 2,756,175,058 tons. In 1814, but twenty-two tons were produced. The total production of both anthracite and bituminous coal since 1814 is 5,577,210,577 tons. The amount produced last year was 351,196,953 tons.

Arc Lamp Resistance, High-Tension Transformers and Autostarters.

When a group of arc lamps is connected in series across a circuit, the drop across the lamps seldom equals the difference of potentials between the lines, and it is, therefore, necessary to introduce a regulating resistance. The accompanying illustrations, Fig. 1 and Fig. 2, show a resistance used with direct-current multiple and series-multiple lamps. One resistance is used with two lamps in series

FIG. 1.—SERIES-MULTIPLE ARC LAMP RESISTANCE, COMPLETE.

on circuits of 220 to 250 volts, and with five lamps in series of 550 to 600-volt circuits, two resistances are used. The successful operation of such a system requires that the resistance be reliable in every particular. Recognizing this fact, the Westinghouse Electric and Manufacturing Company has developed and placed upon the market this resistance which may be suited to a varying range of conditions, is well insulated and thoroughly waterproof, besides having a neat appearance. The wire furnishing the resistance is wound on asbestos-covered bars, which are insulated from the frame by porcelain blocks. This combination of asbestos and porcelain affords protection against fire. A terminal block at the bottom furnishes means for adjustment, so that five different resistances may be obtained by merely changing these connections.

The case and cap are finished in black. The binding terminals are insulated from the metal top by heavy petticoated porcelain insulators; both the terminals and insulators have square stems which prevent them from turning and becoming loose, or twisting off the connections. By means of substantial brackets just under the cap, the assembled outfit may be fastened with screws to the wall or other

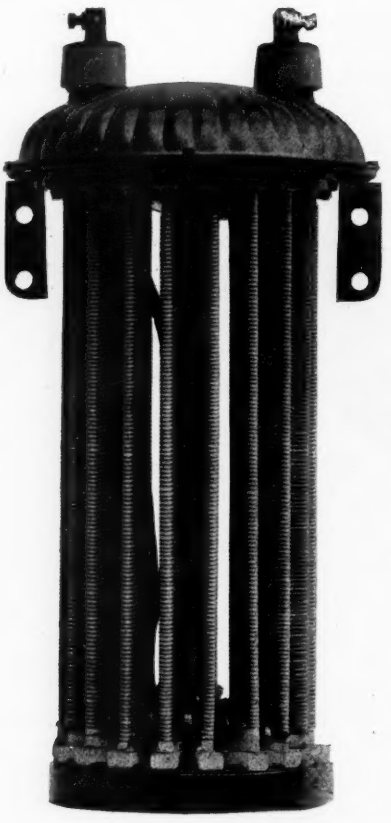


FIG. 2.—SERIES-MULTIPLE ARC LAMP RESISTANCE, WITH COVER REMOVED.

suitable support. The weight of the resistance complete is thirty pounds.

Transmission systems operating at potentials of from 5,000 to 20,000 volts are to-day in common use. While the main object of these systems is to transmit power from a generating station to the centre of distribution, it is often of decided financial advantage for the operating company to retail power along the transmission line. This power may be used for pumping, for the irrigation of farms and ranches, for mill, mine and factory purposes, and for the lighting of small outlying communities. As the volume of business does not always justify the maintenance of a substation, the Westinghouse Electric and Manufacturing Company has developed a line of transformers for this class of service known as the high-tension O. D. type.

The severe conditions of service which these transformers have to withstand have been given great consideration in their design, and a line of apparatus of great ruggedness and durability has been produced. Particular attention has been given to insulating these transformers to withstand the strains due to lightning and static disturbances which occur on high-tension lines. The same method of insulating has been followed as in the large high-voltage apparatus. They are all designed for operation in oil, which acts both as an insulator and as a cooling medium. The transformers have given universal satisfaction wherever installed and have proven themselves to be exceedingly long lived under the most trying conditions.

The smaller sizes (Fig. 3) of high-tension O. D. transformers are mounted in cast-iron cases, larger sizes (Fig. 4) in cases having corrugated sides of heavy sheet steel with heavy cast-iron tops and bases. All cases are absolutely waterproof. The smaller sizes are provided with lugs and hanger irons for mounting on poles, and their light weight makes them convenient to install.

The high-tension winding of these transformers is provided with two taps, by means of which five, ten or fifteen per cent of the total number of turns may be cut out, and the effective winding correspondingly reduced. By applying normal high-tension voltage to any one of these taps, secondary voltage may be boosted in proportion to the number of turns cut out, or the normal low-tension voltage may be maintained when the primary electromotive force falls below its

FIG. 3.—FIVE, AND SEVEN AND ONE-HALF-KILOWATT HIGH-TENSION TRANSFORMER.

rated value. This flexibility of ratio is a valuable feature.

These transformers are manufactured in sizes from one to fifty kilowatts for primary voltages up to 16,500 with 440

and 220 or 220 and 110 as standard secondary voltages. A line with capacities of from ten to fifty kilowatts is arranged for 2,200 and 1,100-volt secondaries, while another line ranging from fifteen to fifty kilowatts supplies low-tension current at 2,400, 2,300, 2,200 or 2,100 volts. The sixty-cycle type may be successfully used on circuits of 6,000 to 16,000 alternations, the twenty-five-cycle type on circuits of 3,000 to 4,800 volts. The maker states that the electrical performance of these transformers is excellent. They show good efficiency at all loads, and the regulation approaches that of central station apparatus.

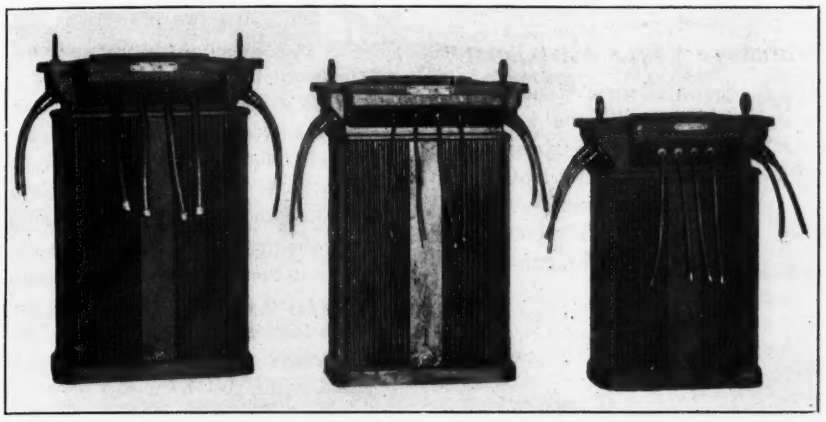


FIG. 4.—TEN, TWENTY AND FIFTY-KILOWATT HIGH-TENSION TRANSFORMERS.

Another new piece of apparatus which the Westinghouse company has placed on the market is an autostarter for a 1,400-horse-power induction motor. An induction motor may be started either by connecting the motor directly to the supply circuit or by applying a low voltage until the motor has attained a fair speed, and then by one or more steps to raise the potential until it reaches its normal value. The first method may be used only with motors under five horse-power, for when the full voltage is impressed on the motor in starting it draws a current equal to several times full-load current, which causes a heavy drop in the supply circuit and is detrimental to the regulation of the system. Further, the excessive strains thrown on the winding of the motor by starting in this manner causes deterioration in the insulation of large-size motors.

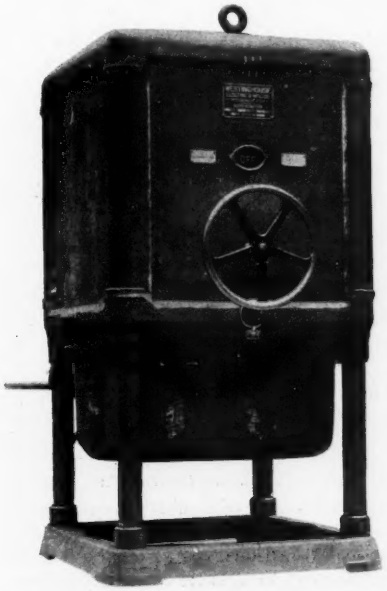


FIG. 5.—CONTROLLER BUILT FOR 1,400-HORSE-POWER, 2,200-VOLT INDUCTION MOTOR.

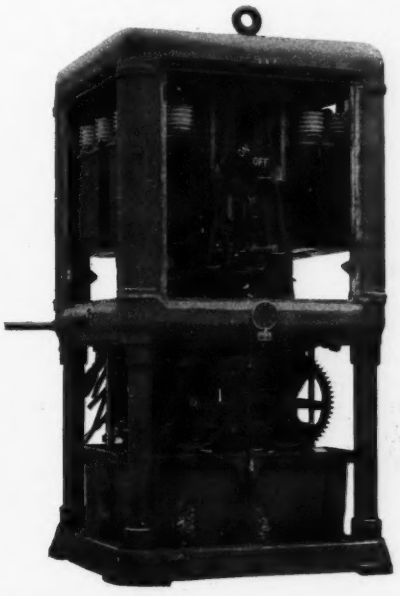


FIG. 6.—CONTROLLER WITH OIL TANK LOWERED AND COVER REMOVED.

These considerations make it necessary to provide an autostarter, which usually consists of an oil-immersed switch or switches of the drum type used in conjunction with two autotransformers, so connected as to apply gradually increasing voltages to the terminals of the motor. The number of points varies from three to nine, depending on the size of the motor. The advantages of a gradual development of torque manifest themselves both in the motor and in the line regulation.

The Westinghouse Electric and Manufacturing Company manufactures oil-immersed autostarters for use with all sizes of constant-speed induction motors from five to 2,000 horse-power, of various voltages, frequencies, and two and three-phase. The one shown in the illustrations, Figs. 5 and 6, was constructed for the control of a 1,400-horse-power, 2,200-volt motor. The switches, circuit-breakers and operating devices only are mounted in the case, and since the autotransformers are standard they are not shown.

This controller, known as type 197, has eight starting and one running points. At the first starting notch a low voltage is impressed on the motor and as each succeeding notch is passed the voltage is increased until the full line potential is reached and the motor attains its running speed. The motor circuit is never opened in passing from one starting point to another, as preventive resistances are inserted between the different notches. Destructive arcing and wear on the contacts are thus prevented, as are also the fluctuations in the line due to starting the motor. The two autotransformers mounted outside the case, in connection with the preventive resistances, furnish the necessary reductions in voltage for starting.

The type 197 controller is equipped with two automatic line circuit-breakers and two non-automatic breakers upon which the circuit is broken when changes in voltage are made, thereby saving the current-carrying contacts of the drum switches. By the first turn of the hand-wheel the circuit-breakers are closed, and the motor is connected to the first point of each autotransformer both direct and through the preventive resistances. The next step connects the motor through another set of resistances to the next higher voltage, disconnects the motor from the lower voltage and finally short-circuits the resistance on the higher voltage step. This is continued with each of the eight steps until the motor is connected to full-line voltage.

The two non-automatic circuit-breakers are actuated by cams connected to the shaft of the hand-wheel, which is turned through 180 degrees for each notch of the controller, the change from point to

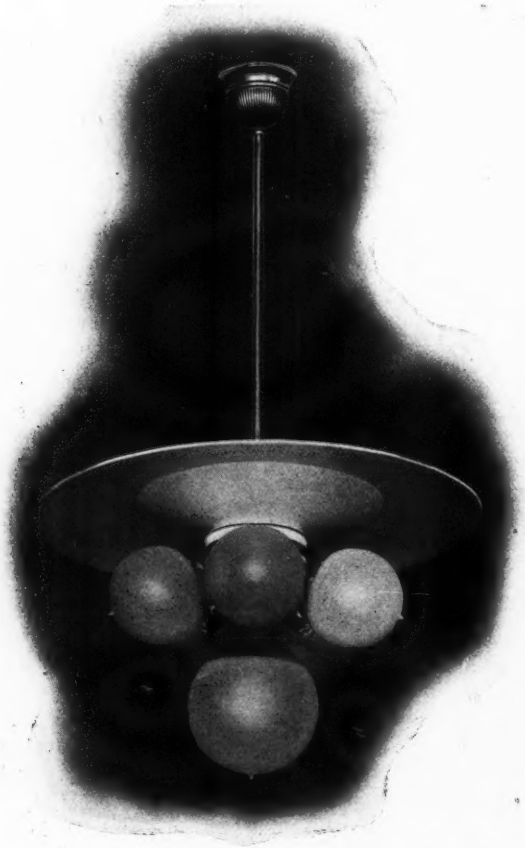
point being shown on the indicator below the wheel. At any position a slight backward turn of the hand-wheel will cause the main-line circuit-breaker to open, and the word "off" to replace the word "on" upon the shutter just above the hand-wheel. An overload on the motor will also cause this breaker to open. In either case it is necessary to return the wheel to the initial starting position before the circuit-breaker can be closed. The tripping coils are so connected that only a part of the turns are in circuit when starting, thus increasing the capacity for the heavy starting currents and ensuring greater protection when running.

The oil tank may be lowered by the crank at the side, and the upper part of the case removed, thus exposing all parts for ready inspection and repair.

This autostarter was designed for starting motors of from 600 to 2,000-horse-power capacity at 2,000 volts, either two or three-phase, the size of motor that can be handled depending on the conditions of service. Direct-current starting rheostats and controllers, though operating satisfactorily when used to start motors driving bucket conveyers where the machinery is started but once or twice a day, will, unless designed for heavy service, heat excessively if used to start motors of the same capacity when driving roll tables and soaking pits where sudden and repeated starting and reversing are required. Similarly, the heating of the autotransformers and the controller contacts depends on the frequency of starting and the starting torque required of the motor. As this apparatus is intended only for starting, it can not be used for varying the running speeds of the motor.

"Turndown" Type "Arc Burst."

The Benjamin Electric Manufacturing Company, Chicago, Ill., the well-known manufacturer of the Benjamin "arc burst," has established a new feature with its "arc burst" cluster which is designated as the "turndown" type. The centre lamp in the "arc burst" can be operated independently of the other lamps by the use of a three-point switch or two switches. This type of "arc burst" will, no doubt, become very popular, as it will make possible the securing of two degrees of illumination. The accompanying illustration shows the regular type of "arc burst." The turndown feature is added only when ordered. If the special style is not specified, the regular style of "arc burst" with one switch will be furnished.



"Arc Burst" Cluster.

New Form of Lamp Socket.

The Electric Lamp Socket Company, 167 Chambers street, New York city, has brought out a new form of lamp socket (patent applied for) for both exterior and interior work. The socket is made in two pieces, constructed of porcelain. The lower portion carries two lugs containing screw holes by which the socket may be attached to the wall of a building. The upper portion contains the screw socket for the lamp, and two projections which correspond with similar projections on the lower piece. The upper portion of the socket has a dowel pin, which fits into a recess in the lower portion, and ensures correct alignment. The wires pass through round holes at the extremities of the two projections, and are screwed to binding-posts on the projections. One binding-post is located in the lower portion of the socket. It is mounted on a brass strip which extends to the centre of the socket. Electrical connection with the lamp is made to this binding-post by means of a brass screw which passes through the centre of the upper portion and enters a tapped hole in the brass strip. The head of the screw bears on one terminal of the lamp. The other binding-post, which is likewise mounted on a brass strip, is located in the upper portion of the socket, and is connected directly to the metallic screw socket of the lamp.

The socket is well designed and strongly constructed, and is especially adapted for outdoor use. The New York Board of Fire Underwriters, and the New York city department of water supply, gas, and electricity have both approved this socket as complying with their regulations when properly installed. About 4,000 of these new sockets were used on the exterior work of the New York Hippodrome, which was described in the Electrical Review for April 29.

The Canadian Westinghouse Company, Limited, Hamilton, Ont., recently sold to the Edmonton (Alberta) Street Railway Company a 200-kilowatt railway generator and a number of double equipments of railway motors. The city of Edmonton is the most northerly point on the American continent to operate an electric street railway. Another recent sale made by the Canadian Westinghouse Company, Limited, was that of a 500-kilowatt, enclosed type turbo-generator unit to the Canadian Pacific Railway Company. This unit is to be installed at Fort William on the Canadian Pacific and to be used for supplying power to the various grain elevators at that point. This unit is to operate three-phase, 600-volt, 7,200 alternations, 3,600 revolutions per minute.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW TELEPHONE COMPANY IN MANILA—A telephone company is being organized in Manila, P. I., with a capital of $300,000. It is proposed to install a thoroughly modern system.

PROPOSED STOCK INCREASE OF THE TWIN CITY RAPID TRANSIT COMPANY—The stockholders of the Twin City Rapid Transit Company, Minneapolis, Minn., are to vote, on May 31, on a proposition to issue $5,000,000 of new common stock. One million of this will be offered to holders at par immediately. The money is to be used in new extensions of the company's lines.

NEW WATER-POWER PLANT IN COLORADO—A company of eastern capitalists, headed by L. W. Beard, proposes to erect a water-power plant near Glenwood Springs, Col. The plant will be the largest in the state. Water will be taken from the Grand river, and, with a 300-foot fall, will develop 100,000 horse-power. Work is to be started in a short time, and the power will be transmitted to Denver.

FORMATION OF HOLDING COMPANY FOR CINCINNATI ELECTRIC ROADS—The Union Traction Company, of Ohio, is being formed under the laws of Ohio, with a capital of $16,000,000. The new corporation proposes to take over the Union Traction Company, of New Jersey, which owns the Cincinnati Traction Company. The object of the movement is to do business under the laws of the state in which the corporation operates. The details of the change are not yet completed.

ESTIMATED COST OF ACQUIRING CHICAGO STREET RAILWAYS BY THE CITY—Mayor Dunne, of Chicago, Ill., has stated that the properties of the Union Traction Company and its consolidated lines, the Chicago City Railway Company, and all other street railways within the city, may be purchased for $50,000,000. Mayor Dunne formerly estimated the price as $77,000,000, based on the valuation of the properties made by Bion J. Arnold. The present estimate is based on the figures submitted by John J. Cummings, a contractor who has been investigating the possibilities of constructing municipally owned lines.

SALE OF THE RIO JANEIRO (BRAZIL) LIGHT, POWER AND TRAMWAY PROPERTIES—The Rio de Janeiro Light, Power and Tramway Company has acquired, through F. S. Pearson, all the lighting companies of the city. This gives the company a monopoly of the light, heat, power and street railway business. The company proposes to install electricity for lighting in place of gas. At the present time there is no electric supply in the city. It is understood that the price paid for the properties was between $6,000,000 and $7,000,000, and it is estimated that the cost of the lighting branch will amount to $1,250,000.

CONSOLIDATION OF PENNSYLVANIA ELECTRIC ROADS—The Pennsylvania & Mahoning Valley Railroad Company and the Youngstown, Sharon & Newcastle Railway Company contemplate a consolidation. The Pennsylvania & Mahoning Valley Railroad Company operates ninety-two miles of road between Newcastle, Pa., and Leavittsburg, Ohio. It has branches to Mineral Ridge and Struthers, Ohio, by way of Youngstown, Newcastle, Niles and Warren. The Youngstown, Sharon & Newcastle company controls forty miles of road between Youngstown, Ohio, and Sharon, Pa. The capital of the former company consists of $5,000,000 common stock and $3,000,000 preferred stock.

ELECTRIC ROAD BETWEEN ATLANTA, GA., AND MACON, GA.—The Atlanta-Macon Interurban Railway Company and the Atlanta Construction and Development Company have been formed with a capital stock of over $2,000,000, in order to build an electric road from Atlanta to Macon, a distance of about seventy-five miles. The road will pass through Forsyth, Barnesville, Griffin, Hampton, Jonesboro, East Point and Hapeville. The survey has already been commenced. The road will be built by the Atlanta Construction and Development Company, and the Atlanta-Macon Interurban Railway Company will operate it. The directors of the two companies are identical. The principal promoters are Charles J. Canfield, of Chicago; George W. Sweigart, Macon; William F. Wocher and J. A. Johnson, of Indianapolis.

SALE OF THE LEHIGH VALLEY AND THE PHILADELPHIA & LEHIGH VALLEY TRACTION COMPANIES—The sale of the Lehigh Valley Traction Company and the Philadelphia & Lehigh Valley Traction Companies has been ordered by the United States Circuit Court under foreclosure proceedings. The Lehigh Valley Traction Company controls all the electric railways in Allentown, Pa., and vicinity. It owns fifty miles and leases 147 miles of road. The Philadelphia & Lehigh Valley company's stock is owned by the Lehigh Valley company, which also guarantees the former company's bonds. It operates a road between Philadelphia and Allentown, Pa., a distance of fifty-two miles.

ELECTRICAL NOTES FROM ARGENTINA—Urien, Shine & Company, of Buenos Ayres, Argentina, have applied to the municipality of Tecuman for a concession to build and operate an electric railroad in that city. The concession for an electric railway system at Buenos Ayres, recently granted to Sawyer & Lacaze, of that city, has been taken up by a company formed of Belgian and Dutch capitalists. The capital of the company is $2,000,000. Plans are being developed for the building of the road. Bids are to be asked from American concerns for the electrification of all the existing horse tramways in Rosario. Particulars of the mileage to be constructed and other terms may be obtained from the Argentine Legation, Washington, D. C.

LEGAL NOTE.

STANLEY TRANSFORMER PATENT DECISION—The United States Circuit Court of Appeals has rendered a decision in the suit of the Westinghouse Electric and Manufacturing Company for a preliminary injunction against the Montgomery Light and Power Company, for alleged infringement of the Stanley transformer patent, reversing the decision rendered by the lower court. The court of appeals holds that in the present motion the depositions deal "with an abstruse and recondite subject, and present conflicting theories which can not safely be accepted without the searching elucidation which a cross-examination of the experts may afford." The court concludes that the right of the parties should be reserved for decision until the final hearing of the cause.

NEW MANUFACTURING COMPANIES.

INDIANAPOLIS, IND.—The Meier Electric and Elevator Company has been incorporated with a capital of $5,000. The incorporators are Frank L. Lewis and Maggie Meier.

BOSTON, MASS.—The Gilman Manufacturing Company has been incorporated with a capital of $100,000 to do a general electrical business. The officers are: president, H. Winthrop Chandler, Auburndale, Mass.; treasurer, James R. Powers, Boston, Mass.

ROCK ISLAND, ILL.—The Tornquist Electrical Manufacturing Company has been organized with a capital of $30,000, to succeed to the business of the Star Metal Stamping and Plating Company. The company will continue the business of the Star company, and, in addition, will manufacture a patent switchboard, a lightning arrester and other electrical appliances. The officers are: president, J. A. Tornquist, of Clinton; vice-president, George L. Osborn; secretary and treasurer, George J. Barker.

NEW PUBLICATION.

RACING RULES OF THE AMERICAN AUTOMOBILE ASSOCIATION—The American Automobile Association has issued bulletin No. 2, which includes the racing rules of the association. In addition to the racing rules are the usual introduction, the lists of officers, directors, committees, members, and reports of directors, and racing board meetings.

ELECTRIC RAILWAYS.

OWOSSO, MICH.—An electric railroad will be built within a few months to West Haven, six miles north of Owosso.

FORT SMITH, ARK.—The Fort Smith Light and Traction Company contemplates making an addition to its power-house.

ALEXANDRIA, LA.—T. G. Bush, of Mobile, Ala., and G. N. Horde, of New Orleans, contemplates the construction of an electric street car line in Alexandria.

BOISE, IDA.—An electric railway line is to be constructed in the Boise valley, reaching Caldwell, thirty-two miles from Boise and the Pearl mining camp, twenty-five miles.

SHAWNEE, O. T.—A franchise has been granted by the council of Tecumseh for an electric railway in that city. The construction of a line to Shawnee must be commenced within ninety days.

PHILADELPHIA, PA.—Directors of the Philadelphia & Easton Street Railway Company have elected new officers as follows: president, George Egolf; secretary and treasurer, A. C. Patterson.

SPRINGFIELD, MO.—The Springfield Traction Company has elected the following directors: W. B. Sanford, A. J. Eisenmayer, H. B. McDaniel, L. H. Murray, W. D. Tatlow, J. Fenton and C. B. McAfee.

BOYERTOWN, PA.—A franchise has been granted to the Boyertown-Palm Electric Railway Company. The line will run through Gilbertsville and Swamp to Limerick where it will connect with the Schuylkill Valley line.

HAVANA, CUBA—The Havana Central Railway Company has organized by electing the following officers: president, Edwin Hanson; vice-president, William L. Bull; secretary and treasurer, C. W. Van Voorhis. The road will extend 120 miles into the interior from Havana.

GALLATIN, TENN.—An electric railway will be built from Gallatin to Cumberland River and Castalian Springs. Those interested are: C. A. Whitesides, J. T. Durham, W. G. Schamberger, William Hall, Lewis Payne, E. O. Buchanan, Granville Johnson, C. B. Brown and C. H. Fidler.

PROVIDENCE, R. I.—The Groton & Stonington Railway was opened for traffic on May 6 from Stonington to Westerly. The entire line from Groton to Westerly, a distance of nineteen miles, is now in operation. The running time is one hour and a half, and one-half-hourly service is maintained.

MEXICO, MO.—An electric line is to be built north and south from Jefferson City, Mo., through Mexico and north to Elden, Iowa, thence to Ottumwa. The road will be built by a Chicago syndicate and will follow the route of the Elden & St. Louis railway, which was surveyed two or three years ago.

ROCKFORD, ILL.—The Chicago & Milwaukee Electric Railroad Company will build a line from Rockefeller to Wauconda, and thence to McHenry, Woodstock, and Belvidere, where it will connect with the Rockford & Interurban company, giving communication with all the larger cities in northern Illinois.

CHARLOTTE, N. C.—James D. Patton and M. M. Martin, of Richmond, Va., and others will build suburban electric lines between Charlotte and Concord, a distance of twenty-four miles, and Charlotte and Gastonia, a distance of twenty-two miles. They will organize a $500,000 company to undertake the work.

LOUISVILLE, KY.—The Louisville & Eastern Electric Railway Company proposes to extend its present line from Beards to Shelbyville, connecting with the Prospect line of the Louisville & Interurban Company with which a freight agreement will be made. Passengers will be transferred to the present line at Beards.

FORT WAYNE, IND.—The Fort Wayne & Wabash Valley Traction Company will build an interurban road from Fort Wayne to Marion, Ind., a distance of fifty miles. It will there connect with the lines of the Union Traction Company. The right of way for the line to Marion has already been secured.

LANCASTER, PA.—Two new lines of electric railway will be built in Lancaster County. One of these is the Lancaster & Eastern Line, between Lancaster and Christiana, seventeen miles, passing through Soudersburg, Leaman Place, Williamstown, Gap and Kinzer. This road will cost $400,000. The work will be finished by next winter. Work is now in progress on the Lancaster & Quarryville trolley road. A third important line is that from Lancaster to Mount Joy, by way of Rohrerstown, a distance of more than twelve miles.

GAINESVILLE, GA.—The Gainesville Electric Railway Company has elected officers and directors as follows: president, A. J. Warner; secretary, W. H. Slack; directors, A. J. Warner, W. H. Carlisle, C. W. Merrick, F. M. Marriott, E. S. Greenleaf, W. H. Slack, H. H. Dean. The Gainesville, Dahlonega & Northern Railway Company has elected as directors: H. J. Warner, W. H. Carlisle, J. F. Moore, C. W. Merrick, E. P. Kirby, W. A. Charters, H. H. Dean. The Gainesville & Dahlonega Electric Railway Company has conveyed to the Gainesville Electric Railway Company all the street railway constructed and completed in Gainesville, and in Hall County, Georgia, and the electric plant on the Chestatee river, together with its dam, pole-line, substations and other property, including franchises. The same company has conveyed to the Gainesville, Dahlonega & Northern Railway the right of way and roadbed from Gainesville to Dahlonega.

TELEPHONE AND TELEGRAPH.

HAMILTON, OHIO—The Home Telephone Company will soon put in an exchange at Trenton.

LYNCHBURG, VA.—The Southern Bell Telephone Company will erect a central office building at Lynchburg.

MINNEAPOLIS, MINN.—The Sleepy Eye Telephone Company will put in seventy-five miles of pole lines this summer.

WELLSBURG, W. VA.—The Home Telephone Company has installed a new switchboard, which will accommodate 400 drops.

ITHACA, N. Y.—Work has been commenced on rural lines to connect Ovid Centre, Kidders, Sheldrake, Covert and Kelly Corners.

BALTIMORE, MD.—The Chesapeake & Potomac Telephone Company is extending its lines to Parkton, *via* the York turnpike.

ROCHESTER, N. Y.—The Seneca County Home Telephone Company is extending its line north to Tyre, and will extend it through the south end of the county.

RENO, NEV.—H. E. L. Reid, president of the Reno street railway, has filed a petition with the Reno city council, asking for a franchise to operate a telephone system.

LONG BRANCH, N. J.—The New York & New Jersey Telephone Company is extending its line between Freehold and Ely. It is expected that connections can be had with Ely in a few days.

WESTERVILLE, OHIO—The city council has granted a franchise to the Bell Telephone Company for the use of its streets and alleys for poles and wires. An exchange is to be put in at once.

STEPHENS, ARK.—The Stephens city council has granted the Southwestern Telephone Company a twenty-five-year franchise for a local telephone exchange. It will be put in as soon as the material can be secured.

READING, PA.—The Pennsylvania Telephone Company will establish an automatic exchange at Fleetwood, the necessary number of subscribers having been secured. The subscribers live in the town and surrounding district.

PARKERSBURG, W. VA.—The Southern Bell Telephone Company, of Charleston, has purchased from A. H. Humphries the telephone line from Charleston to Sissonsville, and will extend it to Parkersburg, making a direct connection with that part of the state.

MONTPELIER, VT.—The Vermont Telephone and Telegraph Company at its annual meeting elected the following directors:

Jasper N. Keller, Francis Houston, E. W. Longley, Carl T. Keller and W. J. Denver, of Boston, and A. C. Brown and J. G. Brown, of Montpelier.

GAGE, OKLA.—A company has been formed, of which J. L. Pryor will act as president, L. Yount as vice-president, Edward T. Massey as treasurer and C. H. Holmes as secretary. The company will put in a complete telephone exchange system at Gage, and extend rural lines through the country.

TROY, N. Y.—The Automatic Telephone Company held its annual meeting recently, when the following directors were chosen: Willis Wendell, James T. Sugden, John K. Stewart, William B. Charles, A. W. Breedon, Louis E. Harrower, Samuel Wallin, Archie R. Conover, Burton Fisher, George McClumpha and Daniel Ostrom.

RENO, NEV.—The first stretch of what the United States government plans to be a big telephone system of its own in Nevada was completed recently, when fifteen miles of wire in Churchill County was placed on a circuit. The new line works in a satisfactory manner. The government will construct many more miles before the end of the year.

YOUNGSTOWN, OHIO—The Warren & Niles Telephone Company, at its directors' meeting, decided to extend its present line from Champion to Bristolville, North Bloomfield and possibly Orwell. At North Bloomfield the company will make connection with home lines from Greene, Mesopotamia and Orwell, thus giving good service to all parts of Trumbull and Ashtabula counties.

ALBANY, ORE.—The Independent Telephone Company has begun work with a large force of men, and expects in a short time to have a switchboard established and several lines from the rural districts connected and in working order. The county is now united with a network of rural telephone lines, and when the connection with Albany is established the system will be practically complete.

HIGH BRIDGE, N. J.—A local telephone line has been organized at Junction, with the following officers: president, T. B. Fulper; secretary and treasurer, Peter S. Shurts; directors, Harry M. Bigelow, Jacob B. Smith, Hiram L. Parcell, W. W. Suppler, Henry Krauss, B. F. Apgar, T. S. Bray and Frank Hopkins. Arrangements will be made by the company to connect with other local lines round about.

CHARLOTTE HALL, MD.—The stockholders of the Southern Maryland Telephone Company have elected the following officials and directors: J. F. Coad, president; J. B. Ballenger, vice-president; L. J. Canter, secretary and treasurer; Zachariah R. Morgan, George M. Thomas. The company is pushing its work vigorously, and will have long-distance connection through the Chesapeake & Potomac Telephone Company at Brandywine, Md., within thirty days.

LINCOLN, NEB.—The annual meeting of the stockholders of the Lincoln Telephone Company was held recently. The reports of officers showed that the Lincoln exchange has 3,343 connecting telephones, including those in College View, Havelock and Cheney, where 318 are in use. Farm line extensions are now in progress. Propositions looking to the building of exchanges in University Place, Waverly and Hickman were discussed and referred to the board of directors.

HARTFORD, CT.—The Southern New England Telephone Company is perfecting plans for rural service, under which farmers and others will have the use of the telephones at a minimum cost of nine dollars per annum, or seventy-five cents per month. The company will offer this arrangement to rural communities everywhere in the state, and will assist in the formation of these rural systems by furnishing telephones, wires, etc.—in fact, the entire equipment desired, except poles, at minimum cost.

ASHTABULA, OHIO—The Ashtabula Telephone Company held its annual meeting on May 1. The company now has 1,545 telephones in commission, a gain of 300 over last year. The stockholders elected the following directors: E. E. Beam, F. E. Henry, V. D. Latimer, J. A. Paisley, W. H. Morrison, B. B. Seymour, S. W. Crosby, W. R. Flower, P. O. Remick. The directors met later and chose the following officers: president, P. O. Remick; vice-president, W. R. Flower; secretary, S. W. Crosby; treasurer, B. B. Seymour. All directors and officers are the same as during the past year.

EASTON, PA.—A new telephone company to operate in Northampton and adjoining counties has been organized with offices at Finesville. The company will be known as the Mutual Telephone Company. Two miles of the line is now being constructed between Finesville and Hughesville, and will connect with the long-distance company at Riegelsville, about half way between these points. Several telephones have been subscribed for and will be in operation about June 1. The following officers have been elected: president, Charles H. Boyer; treasurer, W. I. Jacoby; secretary, W. B. Laubach.

SAN FRANCISCO, CAL.—The Home Telephone Company has filed articles of incorporation. The directors are Henry T. Scott, John J. Mahony, Mark L. Gerstle, Vanderlynn Stow and Richard M. Hotaling, of San Francisco; J. S. Torrance, of Pasadena, and Thomas W. Phillips, of Los Angeles. The last two are directors of the Home Telephone Company, of Los Angeles. The capital stock is $10,000,000, of which $70,000 has been subscribed by the seven directors, each investing $10,000. It is the intention of the new company to install a plant of the best possible construction, including a large conduit system.

WASHINGTON, D. C.—Sealed proposals will be received at the office of the engineer, United States Reclamation Service, Boise, Ida., until two o'clock P. M. June 15, 1905, and thereafter opened, for the construction and completion of a pole line and telephone system about eighteen miles in length, in connection with the Minidoka project, near Minidoka, Ida. Specifications, form of proposal, and particulars may be obtained by applying to H. A. Storrs, electrical engineer, Chamber of Commerce Building, Denver, Col., to the engineer of the Reclamation Service, Boise, Ida., or to the chief engineer of the Reclamation Service, Washington, D. C.

DETROIT, MICH.—Amended articles of incorporation have been filed by the Peninsular Telephone Company, increasing its capital stock from $25,000 to $100,000. The increased capitalization is to provide for building new lines from Detroit to Jackson; Detroit through Pontiac to Flint, and from Detroit to Port Huron, to connect with the Cooperative company in that city. Coincident with the increase in the capital stock in the Peninsular company has come a change in the management of the Cooperative company, C. O. Trask, of Alma, succeeding A. A. Cowles as secretary and manager of the company. Mr. Cowles was elected vice-president at the annual election, at which C. M. Burton was elected president, and J. Ward Howland, treasurer.

FONDA, IOWA—At the regular annual meeting of the stockholders of the Northern Telephone Company the following directors were elected for the ensuing year: L. S. Straight, of Fonda; George Sanborn, Sr., of Fonda; A. S. Wood, of Fonda; L. A. Rothe, of Fonda; M. G. Coleman, of Fonda; M. O. Miller, of Storm Lake; W. P. Miller, of Aurelia; G. F. Tincknell, of Alta, and Jesse J. Allee, of Newell. At the conclusion of the meeting of the stockholders the directors met and elected the following officers: president, L. S. Straight; vice-president, L. A. Rothe; treasurer, A. S. Wood; secretary, M. G. Coleman, all of Fonda. An executive board, consisting of L. S. Straight, George Sanborn, M. G. Coleman, M. O. Miller and W. P. Miller, was elected. An eight per cent dividend was declared.

DRYDEN, N. Y.—The Baldwin County Telephone Company has completed its new telephone line to Bon Secour and Shell Banks, and will lay a cable from Blakely to Mobile, where it will connect with the Southern Bell Telephone exchange, thereby giving day and night service to all parts of Baldwin County. This new line will pass through and have stations at Daphne, Montrose, Fairhope, Battle, Point Clear, Fish River, Baldwin, Rodger Camp and Magnolia Springs, Lyon and Swift's Bon Secour and Shell Banks, besides quite a number of private residences. This is the third telephone line that has been constructed in Baldwin County in the last twelve months. The Home Telephone Company also has a line running down as far as Bon Secour, with quite a number of private connections; also a line from Fairhope to Silver Hill and Albert, Ala.

ELECTRIC LIGHTING.

VERMILLION, S. D.—The voters of Vermillion have declared for municipal ownership of the electric light plant.

BRECKENRIDGE, MO.—The town has voted to issue $10,000 bonds for the purpose of putting in an electric light plant.

ST. LOUIS, MO.—The Union Electric Light and Power Company has had plans prepared for a three-story substation, 33 by 153 feet.

ST. AUGUSTINE, FLA.—J. Clifford Foster, of Tallahassee, Fla., will erect an electric light, heat and power plant in St. Augustine, at a cost of about $50,000.

BLUFFTON, OHIO—The Frederick electric light plant at McComb has been purchased by the village for $3,000. Extensive improvements are to be made.

DETROIT, MICH.—The Peninsular Electric Lighting Company has been granted a thirty-year franchise in Woodmere. The rates are to be those prevailing in Detroit.

PUTNAM, CT.—The Putnam Light and Power Company has elected George H. Hammond president. Allen W. Bowen has been made treasurer and general manager.

PANA, ILL.—The Pana electric light plant has been purchased by H. H. Beckman & Company, of New York. The company has been granted a twenty-five-year franchise by the council.

SAVANNAH, GA.—The Savannah Lighting Company has elected the following officers: president, J. J. Cummings; vice-president, Lawrence McNeil; secretary and treasurer, William Ellis.

TOPEKA, KAN.—The Santa Fé Railway Company plans to build an electric plant sufficient to furnish power for the Argentine shops and light for the yards and offices. The cost is estimated at $48,000.

GRAND RAPIDS, MICH.—The Flint Light and Power Company has elected officers as follows: J. E. Durham, president; D. D. Aitken, vice-president; A. G. Bishop, secretary and treasurer; F. A. Beard, superintendent.

MONTPELIER, VT.—The Vergennes Electric Company has elected directors as follows: E. S. Marsh, C. A. Parker, F. K. Goss; president, C. A. Parker; vice-president, E. S. Marsh; secretary, F. K. Goss; treasurer, C. A. Parker.

NORTH TONAWANDA, N. Y.—A franchise to construct poles and cables in the town of Wheatfield for the distribution of light, heat and power, has been granted to the Niagara, Lockport & Ontario Power Company.

ST. PAUL, MINN.—A franchise has been granted by the city council of South St. Paul to the South St. Paul Heat, Light and Power Company, which will build an electric light plant, and also install a heating system.

BROWNS VALLEY, MINN.—The town of Browns Valley contemplates the installation of an 800-light electric plant. W. D. Graves is chairman of a committee investigating the question. The power used will probably be producer gas.

NEW YORK, N. Y.—The New York Edison Company will build a four-story power-house on the east side of Crosby street, north of Broome street. It will cost $50,000. The company filed plans for $40,000 alterations to its East 121st street power-house.

SHERBROOKE, QUE.—The Power, Light and Heat Company has decided to offer to sell to the city for $233,000. This offer includes the gas works, the real estate and the company's Rock Forest property, which is estimated to be of considerable value.

READING, PA.—An electric light plant is to be built in Tower City by H. T. Bressler. It will provide light for Tower City, Williamstown, Lykens, Wiconisco, Reinerton, Johnstown and Renier's City. Rights of way have been secured in all the above towns.

GOLDENDALE, WASH.—The city council of Goldendale has granted an electric light franchise to H. W. Fellows, of Spokane. He will erect a water-power plant on the Big Klichetal river, fourteen miles west of Goldendale, and supply current for light and power.

WYNNEWOOD, I. T.—A contract has been closed, whereby S. E. Hutchins, of Whitehall, Wis., is to furnish electric light to Wynnewood. The franchise is for fifteen years. Work must be commenced on the plant within sixty days, and it must be in operation in six months.

BLOOMINGTON, ILL.—The Bloomington, Decatur & Champaign Interurban Company has bought the Consumers' electric light and heating plant in Bloomington for $130,000. The new owner will use the plant for a power-house for the new chain of interurban railways to be built shortly.

NILES, MICH.—It is announced that the owners of the Hen Island dam, in the St. Joseph river, seven miles above South Bend, Ind., will build a dam in the river at Bertrand, four miles south of Niles, and that the work will commence soon. Electric power will be transmitted to surrounding towns.

EAST ST. LOUIS, ILL.—The city council of East St. Louis has granted the St. Clair Light and Power Company, of East St. Louis, a franchise to erect poles and stretch wires over the principal business streets in the city. The company must erect an electric light plant, to cost not less than $50,000, within one year.

BAKER CITY, ORE.—The Baker City Light and Power Company has been incorporated with a capital stock of $400,000. The incorporators are F. N. Averill, J. H. Parker and C. A. Johns. The company will take over the properties of the Baker City Gas and Electric Company and the Rock Creek Power and Transmission Company.

COVINGTON, GA.—The White Shoals Power Company will supply electric light to Covington at a cost approximately one-half that of operating the municipal plant. The company has a capital of $150,000, and will build a plant on the Alcovey river, ten miles from Covington. Power will be generated to furnish light to towns within fifteen miles, and eventually power will be furnished to operate cotton mills and other industries.

UTICA, N. Y.—The directors of the Utica Gas and Electric Company have elected the following officers: president, Anthony N. Brady; vice-president, William E. Lewis; treasurer, George H. Stack; secretary, William J. Cahill; executive committee, John S. Maynard, William E. Lewis, Charles S. Symonds, Charles B. Rogers, Samuel A. Beardsley and Anthony N. Brady. M. J. Brayton was made general manager of the electric department, and William J. Cahill general manager of the gas department.

PATERSON, N. J.—The stockholders of the Paterson Electric Light, Heat and Power Company have elected the following directors: Thomas J. Arnold, Ralph Baer, Henry F. Bell, James G. Blauvelt, John S. Cooke, Mangold H. Ellenbogen, William H. Fletcher, Robert Gaede, Isaac A. Hall, John Kane, Angelo H. Knapp, John B. Mason, Charles D. McKelvey, Frederick R. Reynolds, Edward Sceery, Grant Sipp, Leonard J. Tynan, Peter S. Van Kirk. The election of officers by the directors resulted: president, Thomas J. Arnold; vice-president, Peter S. Van Kirk; secretary, Frederick R. Reynolds; treasurer, M. H. Ellenbogen.

PERSONAL MENTION.

MR. L. B. ORME has been appointed manager of the Bristol exchange of the Tennessee Telephone Company, succeeding Mr. Ernest Williams, resigned.

MR. JAMES W. SCOTT, of St. Louis, Mo., has been elected treasurer of the San Marcos Valley Interurban Railway Company, which is building a line in Texas from San Marcos to Luling.

MR. P. A. McCARTHY has been reappointed city engineer of Lufkin, Tex., for a term of two years. He has appointed Mr. J. P. Starns chief deputy and Mr. Frank McCarthy deputy.

MR. PERCY TOWNSEND has taken the position of superintendent of the Wildwood Traction Company, Wildwood, N. J. He was formerly superintendent of the Millville Traction Company.

MR. A. H. PATTERSON celebrated his silver wedding anniversary at his home, 1079 Bergen street, Brooklyn, N. Y., Friday evening, May 12. About one hundred friends were gathered to congratulate Mr. and Mrs. Patterson on the event, and a most

delightful social evening was spent. Mr. Patterson is vice-president and general manager of the Phœnix Glass Company, and is very well known in business circles in New York city and Pittsburg.

MR. LAMAR LYNDON, of New York, the well-known consulting engineer and author, has moved from the Park Row Building to a new suite of offices at No. 80 William street.

MR. WILLIAM CARROLL has been appointed city electrician of Chicago, Ill., in place of Mr. Edward B. Ellicott who has accepted a position with the drainage board. Mr. Carroll has been Mr. Ellicott's first assistant.

MR. FRANK HOFFMEISTER, Winnipeg, Manitoba, has been appointed electrical superintendent of the British Columbia Electric Railway Company, with headquarters at Vancouver. He will assume his new duties June 1.

MR. W. W. ALDERSON has retired from the management of the Central Union (Bell) Telephone Company, Newark, Ohio. He will be transferred to some other department of the company. Mr. Alderson is succeeded by Mr. John A. McManman.

MR. A. C. GARRISON, president of the Columbia Incandescent Lamp Company, St. Louis, Mo., was a visitor in Chicago last week. Mr. Garrison stated that business was very good with his company, and that the outlook was extremely encouraging.

MR. FRANK L. BEAM has resigned his position as general manager of the Citizens' Telephone Company, of Columbus, Ohio. He will devote his entire attention to the Ohio Independent Telephone Association, of which he was recently reelected president.

MR. A. W. PRATT has been appointed district superintendent of the Public Service Corporation of New Jersey, with headquarters at Elizabeth. He will have charge of the operation of the street cars in the city. Mr. Pratt succeeds Mr. J. F. Sparrow who has been transferred to Montclair.

MR. J. T. DARLING has resigned his position as secretary of the Montgomery (Ala.) Street Railway Company. Mr. Darling was the oldest street railway official in Montgomery in length of service, having been associated with the Montgomery Street Railway Company for fourteen years.

MR. ARTHUR E. JACKSON has resigned his position as superintendent of the Willimantic Electric Light and Power Company to take a position in Boston as manager of the Adams-Bagnall Electric Company, of Cleveland, Ohio. He will also be agent for the Gardner Electric Drill and Machine Company. His new office will be in the Boston *Journal* Building.

MR. SAMUEL G. McMEEN delivered an address on May 8, at the Armour Institute of Technology, Chicago, Ill., before the student branch of the American Institute of Electrical Engineers. Mr. McMeen's subject—"Telephone Engineering"—was interesting and instructive, and the young engineers gained considerable information concerning the requirements of an up-to-date telephone engineer.

MR. JOHN GAVEY has been nominated as the president of the Institution of Electrical Engineers, of Great Britain, for the session of 1905-1906. Mr. Gavey is one of the old telegraph engineers of Great Britain. He was born in Jersey in 1842, and entered the service of the Electric and International Telegraph Company in 1860. When the telegraphs were taken over by the state in 1870 he was appointed superintendent of the Southeastern, and afterward the Great Western subdivisions of the southern division of England. In 1878 he became superintending engineer of the South Wales district. In 1892 he was made chief technical officer of the general post office in London. In 1897 he was made second assistant engineer-in-chief. In 1899 he was raised to assistant engineer-in-chief and electrician, and in 1902 he became engineer-in-chief upon the retirement of Sir William Preece. Mr. Gavey has done much to develop and improve the British telegraph system, and deserves a large share of the credit given for the introduction of trunk telephone lines in that country, as he brought about the erection of the first trunk telephone line in 1881. He has contributed numerous papers to the institution and other societies, and is a prominent member of a number of technical organizations of Great Britain.

ELECTRICAL SECURITIES.

Notwithstanding a very apparent nervousness, with irregular fluctuations, the stock market appears to have settled down to a conviction that further retrogression is not in accord with the generally healthy condition of affairs in all industries. In some directions it is a fact that the supply has been creeping up to more than meet the demand, but this is not regarded with any degree of apprehension. The crop outlook, which from now on will be of possibly greater importance than any other index, is decidedly reassuring at the present time. The apparent determination on the part of the great powers involved in the far eastern difficulties to maintain a peaceful situation will also do much to promote a monetary ease which will make possible the financing of any really good proposition which may come along for some time.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MAY 13.

New York:	*Closing.*
Brooklyn Rapid Transit	60⅞
Consolidated Gas	185¾
General Electric	177½
Interborough Rapid Transit	204
Kings County Electric	200
Manhattan Elevated	164⅜
Metropolitan Street Railway	115¾
New York & New Jersey Telephone	171½
Westinghouse Manufacturing Company	190

Consolidated Gas directors have declared a quarterly dividend of 2 per cent, payable June 15. Books close May 26 and reopen June 16. This is a reduction of one-half of one per cent from the previous payment.

At the annual meeting of the General Electric Company, held May 9, the following directors were elected: Gordon Abbott, Oliver Ames, C. A. Coffin, T. Jefferson Coolidge, Jr., W. M. Crane, Frederick P. Fish, George P. Gardner, Eugene Griffin, T. K. Henderson, Henry L. Higginson, J. Pierpont Morgan, J. P. Ord, Robert Treat Paine, 2d., E. W. Rice, Jr., and Charles Steele.

Boston:	*Closing.*
American Telephone and Telegraph	139
Edison Electric Illuminating	247
Massachusetts Electric	64
New England Telephone	138
Western Telephone and Telegraph preferred	98

The instrument statement of the American Telephone and Telegraph Company for the month of April follows: gross output, 174,207; returned, 44,981, making the net output 129,226, as compared with 60,572 for the same month of 1904. The total number now outstanding is 4,910,962.

Philadelphia:	*Closing.*
Electric Company of America	12
Electric Storage Battery common	80¾
Electric Storage Battery preferred	80¾
Philadelphia Electric	11⅞
Philadelphia Rapid Transit	33½
United Gas Improvement	114½

Chicago:	*Closing.*
Chicago Telephone	142
Chicago Edison Light	155
Metropolitan Elevated preferred	61½
National Carbon common	60
National Carbon preferred	114½
Union Traction common	7
Union Traction preferred	33

The report of the Chicago Edison Company for the year ended March 31 follows: gross, $4,051,082; expenses, $2,627,468; net, $1,423,614; charges, $360,232, leaving a surplus of $1,063,382; dividends, $789,262; surplus, $274,120. About 10.78 per cent was earned on the stock. Owing to additions to the capital stock and bond accounts, dividend and interest payments were larger, and the final surplus shows a small reduction as compared with that of the year 1903-1904. The company's total surplus was increased about $175,000 during the year, and another $100,000 was added to the depreciation reserve.

INDUSTRIAL ITEMS.

THOMAS & BETTS, representatives of a number of large manufacturing concerns, have removed their offices to 299 Broadway, corner Duane street, New York.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, has issued catalogue B descriptive of the Weinland turbine-tube cleaners for water-tube boilers.

THE ELECTRIC MOTOR AND EQUIPMENT COMPANY, Newark, N. J., has absorbed the business of the Mason monogram system, used in connection with sign lighting.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has issued bulletin No. 52, describing railway generators. The machines described range in capacity from 150 to 1,500 kilowatts.

THE TETER-HEANY DEVELOPING COMPANY is calling attention to the Heany fireproof insulated wire, which it claims is specially adapted for armature field, transformer and magnet coils.

THE WELLMAN-SEAVER-MORGAN COMPANY is distributing a catalogue entitled "Water-Power Equipment." It describes vertical and horizontal water turbines, and gives a set of power tables of standard turbines.

THE MOORE ELECTRICAL COMPANY, 52 Lawrence street, Newark, N. J., is sending out a booklet describing the Moore electric daylight. The light is produced in a vacuum tube of any length, and is stated to have the same color values as daylight.

THE JENNEY ELECTRIC MANUFACTURING COMPANY, Indianapolis, Ind., in bulletin No. 200 calls attention to its job-press motor equipment. This consists of a motor on a pedestal, an idler pulley for maintaining tension on the belt, a controller and stand for same.

THE STERLING-MEAKER COMPANY, 420 Ogden street, Newark, N. J., is distributing a catalogue describing accessories for street cars. These include the Sterling safety brake, the Sterling fender, trolley wheels, hand-straps, Sterling fare registers, trolley bases, etc.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has issued bulletin No. 91, describing the use of the "chloride accumulator" in the electrification of steam roads. The installations made for the New York Central and the Long Island roads are described and illustrated.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., is distributing cards advertising the "Lundell" universal motor and Christensen air-brake equipments. On the reverse side of the cards are half-tone engravings of the interior of the company's erecting shop, and of a suburban car equipped with the Christensen air-brake apparatus.

JOHN M. KLEIN, president and general manager of the John M. Klein Electrical Works, San Francisco, Cal., has disposed of all his interest in that company. A new company has been incorporated, under the name of the John M. Klein Electrical Company, which will enter the field as electrical jobbers only. The company will discontinue the contracting department which was run by the old firm. The new address is 325 Montgomery street, San Francisco.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, Madison, Wis., has printed a handsome bulletin descriptive of direct-current generators. The frontispiece is a reproduction of an eight-pole Northern ring-type, engine-type generator. Numerous illustrations are given, showing installations of Northern apparatus in different parts of the country. The assembly and detail of manufacture of the Northern motors are plainly indicated, and the bulletin is well worth securing.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed contracts for switchboards for the following places: Ostrander, Minn.; Litchfield, Mich.; Lawnridge, Ill.; Louisville, Ky.; Columbus, Ohio; Adena, Ohio; Nome, N. D.; Plymouth, Neb.; Conotton, Ohio; Kernersville, N. C.; Clatonia, Neb.; Willshire, Ohio; Trivoli, Ill.; Brigham City, Utah; Le Mars, Iowa; Provo, Utah; Liberty, Mo.; Logan, Utah; Rochester, N. Y.; Atlanta, Ga.; Prosser, Neb.

THE WAGNER ELECTRIC MANUFACTURING COMPANY has opened an office at room 417 Rialto Building, San Francisco, Cal., to take care of its Pacific coast business. The office will be in charge of Mr. A. J. Meyers. Previous to this time the Pacific coast business of the company was handled by the Wagner-Bullock Electric Company, which also had charge of the interests of the Bullock Electric Manufacturing Company, of Cincinnati, Ohio. The Wagner company will establish suboffices in Los Angeles and Seattle.

THE ABNER DOBLE COMPANY, San Francisco, Cal., announces that arrangements have been made with the John McDougall Caledonian Iron Works Company, Limited, of Montreal, whereby the latter becomes sole licensee for the manufacture of the Doble system of water-wheels in the Dominion of Canada. The McDougall company has the most extensive machine works in Canada, its plant including machine shops, pattern shop, foundry, forging works and structural material shop. Its plant is therefore well equipped for the manufacture of water-wheels and other hydraulic machinery. The Canadian licensee is prepared to furnish the steel pipe, structural work and all machinery necessary for complete power plants, and the Doble company requests that all engineers or parties interested in water-power development in Canada address the McDougall company direct. It has retained the Abner Doble Company as its consulting engineer.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., announces that the Harbinson & Walker Refractories Company, Pittsburg, Pa., has ordered for its plant at Hays, Pa., one heavy duty horizontal, twenty-two by forty-two-inch Reynolds-Corliss belted engine. This engine is to be non-condensing and operates at seventy-five revolutions per minute, with from 110 to 125 pounds gauge pressure. The city of Hastings, Neb., has arranged for an equipment of an electric lighting plant. The generating unit will consist of heavy duty cross-compound Reynolds-Corliss engine, with cylinders fourteen and twenty-two inches in diameter and thirty-six inches stroke, direct-connected to a 222-kilowatt, single-phase Bullock alternator. The generator is to be provided with an exciter, rheostats and other auxiliary apparatus, and a switchboard panel will be installed. The Republic Iron and Steel Company, Youngstown, Ohio, has placed an order for one horizontal cross-compound condensing Bessemer blowing engine. The high-pressure cylinder will be forty-six inches in diameter, the low-pressure cylinder eighty-eight inches, and the two air-cylinders each of seventy-six inches effective diameter. The stroke is to be sixty inches. The engine will be capable of delivering 24,000 cubic feet of free air per minute at a pressure of twenty-eight pounds per square inch.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., announces that the Newcastle Portland Cement Company, of Newcastle, Pa., has placed an order for two 175-kilowatt, three-phase, alternating-current generators; two forty-two-kilowatt exciters, and the necessary switchboards for the control of this apparatus. These machines will supply current for operating a number of type C induction motors, ranging from 10 to 100 horse-power each, which were also included in the contract. The Western Engineering and Construction Company has ordered 180 horse-power in type F, variable-speed induction motors; 130 horse-power in type C, constant-speed induction motors, and four O. D. transformers. The Cleveland Electric Railway Company will place in its power-house a 1,500-kilowatt, 500-volt, direct-current, engine-type generator and switchboard. Other orders for railway apparatus have been entered as follows: for the Cincinnati Traction Company eight quadruple equipments of No. 85 motors, with unit switch group control; four No. 85 quadruple equipments, with 2-L-4 controllers, and four No. 93-A quadruple equipments, with 2-K-4 controllers. The No. 85 motor has a nominal rating of seventy-five horse-power, and the No. 93-A motor has a capacity of sixty horse-power. The Consolidated Railways Company, of New Haven, Ct., will equip fifteen cars with four No. 93-A motors each and 2-K-6 controllers. The same order included twenty-six No. 101-B motors with K-10 controllers, and seventeen equipments of No. 110-B motors and K-6 controllers.